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INDUSTRIAL ENERGY STUDY OF THE PLASTICS AND RUBBER INDUSTRIES, SICs 282 AND 30

FOSTER D. SNELL, INCORPORATED

PREPARED FOR

FEDERAL ENERGY ADMINISTRATION

MAY 1974

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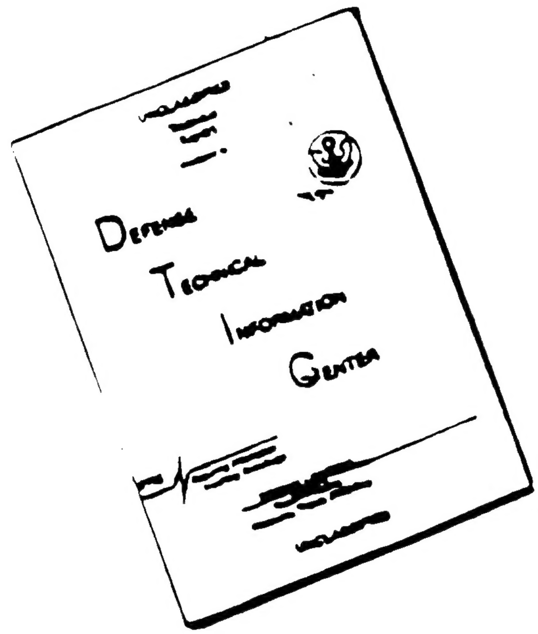

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This study is one of a series conducted in an effort to provide information on the basic structure or characteristics of the Plastics and Rubber Industry. Particular emphasis is placed on fuel use by major type and production process as well as exploring the possibilities for fuel substitutability and conservation alternatives in the Plastic and Rubber Industry.

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ABSTRACT

This technical report presents the results of Foster D. Snell, Inc.'s Industrial Energy Study of the Plastics and Rubber Industries, SICs 282 and 30. Contract supervision was by the Bureau of Mines of the U. S. Department of Interior under contract number 14-01-0001-1655. Technical project supervision was provided by the Bureau of Domestic Commerce of the U. S. Department of Commerce. These agencies acted on behalf of the Federal Energy Office.

The purpose of the study is to provide the government with a comprehensive energy and energy-related data base and a definition of the economic impacts of the energy shortages in the SIC groups studied. The generation of standardized statistics, energy utilization assessment and economic impact evaluation are the three major deliverables. In the study, Snell information, industry representatives, related associations, and the literature provided the necessary data base. Over 140 interviews were completed.

The plastics and rubber industries comprise a rapidly growing sector of the economy which, in 1971, employed over 720,000 workers. In 1973, the total energy requirement of these industries was about 971 x 10^{12} BTUs, of which 13% was direct use of fuel oils. The fibers, synthetic rubber and tire industries are highly regionalized while the plastics materials, plastics processing and rubber products industries are distributed in the industrial states. These industries can generally also be subdivided in terms of major processes with distinct energy profiles.

There are no major near-term opportunities to substitute and conserve petroleum-based fuels. In the longer term, however, appreciable opportunities may exist to substitute coal for oil or natural gas. There is also an opportunity to impact intra-industry energy efficiency and flexibility through improvements in process design.

Supplies of fuel oil have been generally adequate in the rubber and plastics industries during 1973 and the first quarter of 1974. The principal constraint on these industries' operations was shortages of petroleum-based raw materials. These shortages had an appreciable economic impact on the industries classified in SICs 282 and 30.

Based on the findings and conclusions of the study, it is recommended that a study be initiated to survey the use of petroleum-based raw materials in the plastics and rubber industries. A second study to define the technical opportunities and strategies for optimizing petroleum-based fuels and raw materials use in these industries should also be initiated.

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FEDERAL ENERGY ADMINISTRATION: NOTES AND OBSERVATIONS

This Industry Energy Study was prepared in response to the Arab Oil Embargo of last October and a conscious effort to conserve energy.

At the time, it was uncertain how long the embargo would continue or how severe it would be. Consequently, it was necessary to obtain information that would be useful in operating the Federal Energy Office's emergency allocation scheme for petroleum products.

While the study was a concentrated effort on the part of the contractor with the general assistance of industry representatives, it was nevertheless prepared under severe time constraints and neither the views nor opinions expressed in this study represent those of the Federal Energy Administration or the Federal Government.

In the report prepared by Foster D. Snell Inc. the contractor took all possible steps, within the time and funding constraints, to provide the information required by the RFP. Under the circumstances, given these constraints, the scope, general approach, and conclusions are acceptable as initial views of the energy characteristics of the plastics and rubber industries. Considerable further

research is necessary in some areas, however, before fully useful data can be developed. Some general observations that can be made regarding the report are the following:

1. The utility of measuring energy efficiency in terms of Btu per unit of value of shipments is somewhat questionable, since the denominator of such a ratio is affected by changes in price levels over time.
2. The usefulness of the derived geographic energy patterns, based on using the national energy factor as a multiplier of the production volume, appears to be quite limited at best. Patterns of energy may vary regionally as well as by plant.
3. Since 1974 projections are based on an average of "high" and "low" production estimates and actual values may well be affected by plant or company variation, these should be used with great caution.
4. The use of 1972 definitions for SICs 2821 and 3079 required some complex data manipulations to provide estimates of energy use by type for these industries. Energy factors were computed based on 1967 SIC definitions, but were applied

to production reflecting the 1972 definitions. The validity of this approach is open to question, but could not be checked out with available data.

5. There are a number of typographical errors that might confuse a reader:

   (a) Page IV-12. The reduction in production should be to 75% rather than by 75%.

   (b) Page IV-18. Nylon 6 cutback was 20% rather than 80%, and acrylic curtailment was 10% rather than 90%.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies of the U.S. Government.

INDUSTRIAL ENERGY STUDY OF THE PLASTICS AND RUBBER INDUSTRIES, SICs 282 AND 30

FEDERAL ENERGY OFFICE/U. S. DEPARTMENT OF COMMERCE

Under

CONTRACT NO. 14-01-0001-1655 OF THE BUREAU OF MINES

MR. VIRGIL KETTERLING, TECHNICAL PROJECT OFFICER

May 10, 1974

by

FOSTER D. SNELL, Inc.

Subsidiary of Booz, Allen & Hamilton, Inc.
Hanover Road
Florham Park, N. J.

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SECTION I

INTRODUCTION

This technical report presents the results of Foster D. Snell, Inc.'s (Snell's) Industrial Energy Study of the Plastics and Rubber Industries. These industries are under Standard Industrial Classification (SIC) groups 282 and 30, respectively.

Contract supervision was by the Bureau of Mines of the U. S. Department of Interior under contract number 14-01-0001-1655. Technical project supervision was provided by the Bureau of Domestic Commerce of the U. S. Department of Commerce. These agencies acted on behalf of the Federal Energy Office.

The contract performance period was two months. February 1, 1974 was the project initiation date. This chapter describes the background of the study, the basic approach taken, required deliverables, and provides a brief profile of the industries studied.

1. THE PURPOSE OF THE STUDY IS TO PROVIDE THE GOVERNMENT WITH A COMPREHENSIVE ENERGY AND ENERGY-RELATED DATA BASE AND A DEFINITION OF THE ECONOMIC IMPACTS OF THE ENERGY SHORTAGES IN THE SIC GROUPS STUDIED

- The Department of Commerce's Industrial Energy Analysis Group is responsible for laying the foundation for a systematic and comprehensive energy and energy-related data base for the industrial sector of the economy.

- The principal work mandate concerned fuels and energy use but much useful information was assembled regarding raw materials.

2. THE STUDY SCOPE ENCOMPASSED THREE MAJOR DELIVERABLES: THE GENERATION OF STANDARDIZED STATISTICS, ENERGY UTILIZATION ASSESSMENT AND ECONOMIC IMPACT EVALUATION

- Exhibit I-1, at the end of this section, presents the breakdown of the industry sectors studied.

- these include the industries involved in the manufacture and processing of plastics and rubber materials.

- the nine basic industries encompass more than 8,000 establishments employing over 700,000 people.

- each four digit SIC sector was separately studied

- the exhibit also lists the industry associations cooperating with the study, as these relate to the specific sectors.

· Exhibit I-2, following Exhibit I-1, presents a summary of the principal tasks and the related major deliverables.

3. DELIVERABLES WERE DEVELOPED FROM SNELL INFORMATION AND DATA FROM OUTSIDE SOURCES

Description of specific approaches follows. These work steps were required in the study of each four digit SIC category.

(1) Energy Factors Were Used In Developing The Required Tables For Major Uses Of Fuels, Energy And Petroleum Products

· The Required Tables appear in the second exhibit of each chapter dealing with a specific four digit SIC industry.

· Based on census, literature and industry data the study team defined the proportion of industry output accounted for by each major process or product for 1973 - Required Table 1.

· The study team developed an "energy factor" (EF) for representative major processes or subprocesses as well as an EF for each industry.

  - the EF is expressed in terms of "amount of each type of energy or material per unit of production"

  - data sources include census information, the Snell files and industry interviews

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- Multiplying the annual production (or shipment) value by the proper EF provides:

  - Required Table 5, dealing with industry level consumption of fuels, petroleum products, and energy by type for 1971, 1973 and 1974

  - Required Tables 2, 3, and 4 in terms of processes and subprocesses and dealing with the same items as above. Type of energy or material were disaggregated into "heat and power, material and other" using historical census data and results of interviews

- Required Tables 6 and 7 deal with geographic breakdown of the consumption of fuels, petroleum products and energy. Industry level data were disaggregated using historical data on distribution of employment, shipments or plant capacities. Census data, the literature and industry were information sources.

- Required Table 8 concerning shipments, employment, and fuels and energy consumed geographically was assembled from data related to the tables already named above.

- The study team attempted to define stocks of fuels and petroleum products, Required Table 9, through:

  - industry interviews
  - limited surveys (9 or fewer questionnaires) for each sector

- The approach was the same as above for Required Tables 10, 11, and 12, dealing respectively with captive consumption, sources of supply, and seasonal use.

(2) <u>Interviews With Industry Sources Were The Principal Source Of Information On The Substitutability And Conservation Of Major Fuels And Petroleum Products As Well As Intra-Industry Efficiency</u>

- The principal sources of information are Snell's internal resources, the literature and a limited number of industry interviews.

- The study team examined census historical trends in fuels and energy use

- The study team attempted to identify significant production parameters that determine efficiency

- The study team attempted to define efficiency as well as substitutability differences between large and small plants

(3) Outside Surveys And Industry And Related Interviews Provided The Basis For Identifying Principal Constraints And Economic Impacts On Current Industry Operations

- The literature related to the industries studied gives considerable attention to the impacts of the fuel, energy and petroleum-based products shortages. This was a major information source.

- Interviews contributed qualitatively in obtaining current information on these subjects.

4. DEFINITIONS OF ENERGY FORMS WERE DEVELOPED AT THE OUTSET OF THE STUDY TOGETHER WITH DESCRIPTIONS OF THE MANDATORY PETROLEUM ALLOCATION PROGRAMS

- Exhibit I-3, following Exhibit I-2, presents a set of definitions for the non-obvious terms of "Type of Energy or Material" in the Required Tables.

- Exhibit I-4, following Exhibit I-3, summarizes salient aspects of the mandatory allocation program potentially affecting the industries studied.

5. LIMITATIONS IN THE STUDY RESULTED PRIMARILY FROM THE TIME CONSTRAINTS INVOLVED AND LACK OF STATISTICALLY HARD DATA IN SOME AREAS

- The two month time frame of the study did not permit appreciable "original" work. Rather, the study team efforts were confined to the review and assimilation of readily available relevant information. However, the available data were supplemented by industry interviews.

- A summary of interviews is presented in Exhibit I-5, following Exhibit I-4.

- The over 140 interviews of the study, while substantial in number, did not provide statistically sufficient sampling of some of the sectors studied.

6. <u>THE DETAILED METHODOLOGY USED AND THE FACTORS AFFECTING THE DATA RELIABILITY ARE PRESENTED AS CONCISE FOOTNOTES WITH EACH REQUIRED TABLE OR OTHER EXHIBIT IN EACH INDUSTRY STUDY</u>

- Detailed methodology is an integral part of each Required Table or exhibit.

- The same reliability rating applies to large blocks of data in many of the Required Tables because the source is the same or the approach is the same for individual figures in a block.

- Thus, for the sake of conciseness of presentation and report brevity, possible error ratings are summarized in a single exhibit in Appendix B.

7. <u>IN 1971 THE SIC 282 AND 30 INDUSTRIES EMPLOYED OVER 720 THOUSAND WORKERS, AND REPRESENTED AN IMPORTANT SEGMENT OF THE ECONOMY</u>

- Exhibit I-6, following Exhibit I-5, presents a summary of the 1971 structure of the plastics and rubber industries

  - SIC groups 282 and 30 represented approximately 4.1 percent of employment in all operating manufacturing establishments

  - the value added by manufacture by these SIC categories was over $14,300 million, representing approximately 4.6 percent of the value added by all operating manufacturing establishments

  - the value of SIC 282 and 30 industry shipments represented $26,400 million or 3.9% of all manufacturing industry shipments

- the plastics and rubber industries held about 8.2 percent of gross book value of depreciable assets of all operating manufacturing establishments

- these industries have about 8,200 establishments

. Exhibit I-7, following Exhibit I-6, summarizes the relative importance of each sector in the SIC 282 and SIC 30 groups in terms of employment and value added. SIC 3079, Plastics Products, is most important in these terms.

. Exhibit I-8, following Exhibit I-7, profiles the industries studied regarding fuels and electric energy used in 1971.

  - the rubber and plastics industries accounted for

    .. 4.9 percent of purchased fuels by all industries

    .. 5.4 percent of purchased electric energy by all industries

  - the rubber footwear and reclaimed rubber industries are negligible users of fuels and electric energy, compared to the other sectors

. Exhibit I-9, following Exhibit I-8, profiles the industries studied regarding specific types of purchased fuels used for heat and power in 1971.

  - the industries studied accounted for 6.1 percent of fuel oil usage by all industry

  - the industries studied accounted for 12.4 percent of coal usage by all industry

  - the industries studied accounted for 3.6 percent of fuel gases used by all industry

*   *   *   *

The section that follows presents the overall study conclusions and findings.

EXHIBIT I-1
Federal Energy Office: U.S. Department of Commerce
INDUSTRY SECTORS STUDIED

SIC	INDUSTRY	COOPERATING INDUSTRY ASSOCIATION
2821	Plastics Materials	Society of the Plastics Industry
2822	Synthetic Rubber	International Institute of Synthetic Rubber Producers
2823	Cellulosic Man-made fibers	Man-made Fiber Producers Association
2824	Organic Fibers	Man-made Fiber Producers Association
3011	Tires	Rubber Manufacturers Association
3021	Rubber Footwear	Rubber Manufacturers Association
3031	Reclaimed Rubber	Rubber Reclaimers Association
3069 (1)	Rubber Products	Rubber Manufacturers Association
3079	Plastics Products	Society of the Plastics Industry

(1) SIC 3041, Rubber and Plastics Hose and Belting, is included in SIC 3069 for purposes of this study.

EXHIBIT I-2
FEO: USDC
MAJOR TASKS

TASK (Separately for each four digit SIC industry)	DELIVERABLE TYPE	DELIVERABLE
1. Define major uses of fuels, energy and petroleum products 2. Define geographic patterns of use 3. Define fuel and energy supply situation	Standardized Statistics	"Required Tables" 1 thru 12 and discussion
4. Assess substitutability and conservation of major fuels and petroleum products 5. Assess intra-industry efficiency	Energy Utilization Assessment	Assessment
6. Assess principal constraints on current industry operations	Economic Analysis	Analysis with emphasis on employment impacts

EXHIBIT I-3
FEO: USDC
DEFINITION OF ENERGY TERMS

Term	Definition
1. Propane, Butane and Mixtures	"Propane" means a hydrocarbon whose chemical composition is predominantly C_3H_8, including propane (1) in raw mixed streams of natural gas liquids, whether or not further fractionated or processed to recover propane, and (ii) propane-butane mixes. "Propane-butane mix" means a mix containing ten (10) percent or more by weight of propane. (§ 211-82)
2. Middle Distillates or Distillates	"Middle distillate" means any derivatives of petroleum including kerosene, home heating oil, range oil, stove oil, and diesel fuel, which have a fifty percent boiling point in the ASTM D86 standard distillation test falling between 371° and 700°F. Products specifically excluded from this definition are kerosene-base and naphtha-base jet fuel, heavy fuel oils as defined in VV-F-815C or ASTM D-396, grades #4, 5, and 6, intermediate fuel oils (which are blends containing #6 oil), and all specialty items such as solvents, lubricants, waxes, and process oil. (§ 211-51)
3. Residual Fuel Oil or Residual	"Residual fuel oil" means the fuel oils commonly known as (1) No. 4, No. 5 and No. 6 fuel oils; (2) Bunker C; (3) Navy Special Fuel Oil; (4) crude oil when burned directly as a fuel; and all other fuel oils which have a fifty-percent boiling point over 700°F. in the ASTM D-86 standard distillation test. (§ 211-51)

Term		Definition
4.	Chemical Feedstocks or Feedstocks (Officially Petrochemical Feedstocks)	"Petrochemical feedstocks" means crude oil, residual fuel oil, and refined petroleum products which can be processed in a petrochemical plant, including naphtha, gas oil, kerosene, and heavy aromatic gas oil used for production of carbon black. Petrochemical feedstocks do not include ethylene, propylene, butylene or any item otherwise defined as a petrochemical or natural gas. "Petrochemicals" means the items defined as such in section 25A of Oil Import Regulation 1 (Revision 5), (32A CFR OI Reg. 1. 25A). For the purpose of this subpart, synthetic natural gas is not considered to be a petrochemical. (§ 211-183)
5.	Other Petroleum Products	By exclusion, those products listed as specialty items in the middle distillate definition, that is: solvents, lubricants, waxes and process oil. Under the heading of, "Other Petroleum Products", Snell included volumetric data on major raw materials used in some SIC categories.

Source for items 1 through 4:

FEO Regulations for Mandatory Petroleum Allocations 10 CFR-211 Jan. 15, 1974

EXHIBIT I-4
FEO: USDC
FUEL ALLOCATION REGULATIONS AFFECTING THE PLASTICS AND RUBBER INDUSTRIES

Fuel	Allocation
Propane and propane-butane mix	An allocation of 90 percent of base period use was set for industrial use where no substitute is available, standby volume consumed during the base period, or 210,000 gallons per year, whichever of the three is less; petrochemical and petrochemical precursor production.
Butane regulations	The allocation scheme provided 100 percent of current requirements for petrochemical production. One hundred percent of base period was provided for industrial use where no substitute for butane is available, or standby volumes of butane consumed during base period, or 210,000 gallons per year, whichever of the three is less.
Motor gasoline regulations	The regulations established the corresponding month of 1972 as the base period. The allocation for all other businesses is 100 percent of base period use. FEO spokesmen said that 100 percent of base period use would translate itself into a 7-10 percent reduction of anticipated 1974 demands.
The middle distillate allocation	The scheme applies to kerosene, Number Two heating oil, and diesel fuel. The base period is the corresponding month of 1972. Industrial and manufacturing uses, except space heating, will be allocated 110 percent of base period volume.
Aviation fuel	Not applicable

EXHIBIT I-4 (Cont.)
FEO: USDC
FUEL ALLOCATION REGULATIONS AFFECTING THE PLASTICS AND RUBBER INDUSTRIES

Fuel	Allocation
. The residual fuel oil program	The program includes Numbers Four, Five, and Six fuel oils, Bunker C, Navy Special Fuel Oil, and crude oil burned directly as a fuel. The base period for all nonutility uses is the corresponding month of 1973. Other heating uses, except medical and nursing buildings, were based on a 10-degree thermostat reduction or equivalent. There was a 100 percent of base period volume provided for industrial users.
. The petrochemical feedstock (as defined in Exhibit I-3)	The allocation level is designed so that, to the extent practicable, when supplies are added to nonallocated supplies, the producer will have 100 percent of current requirements. Priority in assigning suppliers will be given to producers whose traditional suppliers cannot meet their obligations and to producers attempting to restore 1972 production. Lower priority will be assigned to petrochemical producers seeking to expand beyond those levels. There is no state set-aside.
. Lubricants and other products	The program provided that an amount equal to current requirements will be allocated to each wholesale purchaser. Any purchaser who has difficulty securing necessary supplies may petition the FEO regional office for assignment of a new supplier. There is no state set-aside.

Source: BNA, Energy Users Report, No. 23, 1-17-74, pp. 17-18.
Federal Register 39: 744-770,2.

EXHIBIT I-5
FEO: USDC
SUMMARY OF INTERVIEWS (1)

SIC	Interviews (2) Firms	Related Organizations	Total
2821	22	6	28
2822	8	6	14
2823	4	3	7
2824	2	3	5
3011	4	4	8
3021	11	3	14
3031	4	4	8
3069	12	6	18
3079	14	8	22
General Informational Interviews	81	43	124
Technical Information	(x)	5	5
Governmental	(x)	14	14
Grand Totals	81	62	143

(1) Interview write-ups are located in the Snell Working Files.
(2) The overwhelming majority of the interviews made by Snell personnel provided significant and useful information.

EXHIBIT I- 6

FEO: USDC

1971 STRUCTURE OF THE INDUSTRIES STUDIED (1)

Code	Industry Group and Industry	All Employees Number (1,000)	Value Added By Manufacture (million dollars)	Value Of Industry Shipments (million dollars)	Total Gross Book Value Of Depreciable Assets, End of Year (million dollars)	Approximate Number Of Establishments (2)
282	Plastics Materials and Synthetics	180.8	4,799.8	9,345.6 (3)	8,961.8	
2821	Plastics Materials and Resins	73.2	2,068.0	4,399.2	3,759.0	800
2822	Synthetic Rubber	12.2	476.7	1,042.6	740.0	50
2823	Cellulosic Manmade Fibers	20.2	349.6	662.4	623.7	25
2824	Organic Fibers, Noncellulosic	75.2	1,905.4	3,241.4	3,839.1	70
30	Rubber and Plastics Products, NEC	543.5	9,521.2	17,043.7	8,212.5	
3011	Tires and Inner Tubes	104.8	2,766.8	5,231.9	2,827.1	200
3021	Rubber Footwear	29.2	297.2	519.8	150.2	80
3031	Reclaimed Rubber	1.2	17.8	32.1	26.1	30
3069	Fabricated Rubber Products, NEC	126.1	2,003.0	3,495.0 (3)	1,498.2	1,100
3079	Miscellaneous Plastics Products	282.2	4,436.3	7,765.0 (3)	3,710.9	5,800
A	Total for 282 and 30 industries	724.3	14,321.8	26,389.3	17,174.3	8,200
B	All Operating manufacturing establishments	17,426.3	314,151.7	670,970.5	277,419.3	
C	A as percent of B	4.1	4.6	3.9	8.2	

Sources and Footnotes:

(1) Annual Survey of Manufactures, 1971, unless otherwise indicated.

(2) County Business Patterns, 1972

(3) Value quoted in Annual Survey of Manufactures before redefinition of these industries in 1972 census.

EXHIBIT I-7
FEO: USDC
THE RELATIVE IMPORTANCE [1] OF EACH SECTOR IN THE SIC 282 AND SIC 30 INDUSTRIES IN TERMS OF EMPLOYMENT AND VALUE ADDED

Code	Industry	A Percent of All Employees	B Percent of Value Added by Manufacture	C Importance Rating [2]
2821	Plastics Materials and Synthetics	10.1	14.4	2
2822	Synthetic Rubber	1.7	3.3	3
2823	Cellulosic Man-made Fibers	2.8	2.4	3
2824	Organic Fibers, Noncellulosic	10.4	13.3	2
3011	Tires and Inner Tubes	14.5	19.3	2
3021	Rubber Footwear	4.0	2.1	3
3031	Reclaimed Rubber	0.2	0.1	3
3069	Fabricated Rubber Products, n.e.c.	17.4	14.0	2
3079	Miscellaneous Plastics Products	39.0	31.0	1
	Total	100.1	99.9	

Sources:
(1) Based on data for 1971 from Exhibit I-6.
(2) Based on the relative values in columns A and B: "1" is most important

EXHIBIT I-8
FEO: USDC

FUELS AND ELECTRIC ENERGY USED BY THE INDUSTRIES STUDIED COMPARED WITH USAGE BY ALL INDUSTRIES FOR 1971[1]

Code	Major Industry Group and Industry	Total Cost Of -- Purchased Fuels and Electric Energy (million dollars)	Total Cost Of -- Purchased Fuels (million dollars)	Electric Energy: Purchased Quantity (million kw.-hrs.)	Electric Energy: Purchased Cost (million dollars)	Electric Energy: Generated Less Sold (million kw.-hrs.)
	All Industries, Total	10,441.1	5,360.8	517,780.4	5,079.9	82,750.1
282	Plastics Materials and Synthetics	286.5	173.8	13,653.2	112.7	3,243.0
30	Rubber and Plastics Products, n.e.c.	268.1	89.8	14,396.6	178.3	668.3
301	Tires and Inner Tubes	70.9	29.6	4,136.4	41.3	
302	Rubber Footwear	5.1	1.8	238.3	3.3	
303	Reclaimed Rubber	1.9	0.6	142.6	1.3	
306	Fabricated Rubber Products, n.e.c.	58.3	24.9	2,706.3	31.3	
307	Miscellaneous Plastics Products	134.1	33.0	9,173.0	101.1	
B	Total 282 and 30		263.6	28,049.8		
C	Total 282 and 30 as Percent of Total for All Industries		4.9	5.4		

Source:
(1) Annual Survey of Manufactures, 1971.

EXHIBIT I-9
FEO: USDC

QUANTITY AND TYPE OF PURCHASED FUELS USED FOR HEAT AND POWER IN 1971 (1) BY THE INDUSTRIES STUDIED COMPARED WITH ALL INDUSTRIES

Code	Industry Group and Industry	Kilowatt-Hours Equivalent (billions)	Fuel Oil: Total Quantity (1,000 barrels)	Fuel Oil: Distillate Quantity (1,000 barrels)	Fuel Oil: Residual Quantity (1,000 barrels)	Bituminous Coal Lignite and Anthracite Quantity (1,000 short tons)	Coke and Breeze Quantity (1,000 short tons)	Natural Gas Quantity (billion cu. ft.)	Other Fuels (million dollars)	Fuels Not Specified By Kind (million dollars)
282	Plastics Materials and Synthetics	118.7	9,784.2	3,638.8	6,145.4	6,349.7	-	153.9	10.0	4.1
2821	Plastics Materials and Resins	39.3	4,886.8	1,610.3	3,276.5	1,419.4	-	52.3	6.2	2.8
2822	Synthetic Rubber	17.3	175.6	162.1	13.4	238.2	-	49.0	3.4	-
2823	Cellulosic Manmade Fibers	23.5	303.8	136.9	166.9	2,440.4	-	11.6	-	.7
2824	Organic Fibers, Noncellulosic	38.6	4,418.1	1,729.5	2,688.6	2,296.8	-	41.0	.3	.6
30	Rubber and Plastics Products, n.e.c.	51.3	5,279.3	2,902.1	2,377.2	1,243.9	-	76.6	2.7	12.3
3011	Tires and Inner Tubes	19.6	1,769.2	1,220.9	548.3	824.3	-	28.9	.1	2.0
3021	Rubber Footwear	.8	195.0	119.4	75.7	1.0	-	.7	.3	.3
3031	Reclaimed Rubber	.3	12.0	5.8	6.2	17.3	-	.5	.2	(z)
3069	Fabricated Rubber Products, n.e.c.	13.1	1,925.4	682.7	1,242.7	324.7	-	19.6	.9	1.5
3079	Miscellaneous Plastics Products	17.3	1,377.7	873.4	504.2	76.6	-	27.0	1.2	8.4
A	Total for 282 and 30	170.0	15,063.5	6,540.9	8,522.6	7,593.6	13,742.8	230.5	377.5 (3)	458.2
B	All Industry	3,332.4	245,667.2	104,940.8	140,726.4	61,392.6		6,454.4 (2)		
C	A as Percent of B	5.1	6.1	6.2	6.1	12.4		3.6		

Sources:

(1) 1972 Census of Manufactures, MC72 (SR)-6.
(2) Gas (natural manufactured, still, blast-furnace, and coke oven)
(3) Other fuels (gasoline, LPG, wood, and purchased steam) (million dollars)

SECTION II

FINDINGS AND CONCLUSIONS

The discussion below summarizes overall findings and conclusions from study of the nine four digit SIC industries, presented in Sections IV through XII.

Together with Section III, Recommendations, this section serves as a concise executive summary of the key outputs from the study.

1. **THE TOTAL 1973 ENERGY REQUIREMENT OF THE INDUSTRIES STUDIED WAS ABOUT 971 x 10^{12} BTUs, OF WHICH 13% WAS DIRECT USE OF PETROLEUM BASED FUELS**

    - SICs 2821, 2824, and 3079 accounted for 59% of the 1973 energy consumption of the plastics and rubber industries.

SIC	Industry	Energy Requirements (10^{12} BTUs) 1971	1973	1974
2821	Plastics Materials	156	221	236
2822	Synthetic Rubber	78	89	92
2823	Cellulosic Fibers	81	68	66
2824	Non-Cellulosic Fibers	170	220	237
3011	Tires	106	106	115
3021	Rubber Footwear	4	4	4
3031	Reclaimed Rubber	2	2	2
3069	Rubber Products	70	88	90
3079	Plastics Products	160	173	190
	Total	827	971	1,032

- The overall increase in energy needs from 1971 to 1973 was 17%, while from 1973 to 1974 this is expected to average 6%.

- There are appreciable differences in the sources of energy among the industries studied, seen from the table below.

SIC	Fuel Oils	Coal	Natural Gas	Purchased Electricity	Total
	Percent of 1973 BTUs				
2821	15%	13%	25%	46%	99%
2822	1	6	67	23	97%
2823	11	68	13	8	100%
2824	23	27	24	26	100%
3011	13	13	33	41	100%
3021	28	1	18	53	100%
3031	3	20	31	46	100%
3069	17	8	34	41	100%
3079	4	1	27	68	100%
10^{12} BTUs	130	165	289	385	996
% of Total	13	17	30	40	100%

- From the table above roughly 130 x 10^{12} BTUs are directly subject to Mandatory Petroleum Allocation Regulations (MPAR).

- An appreciable portion of the purchased electricity is generated by the public utility industry using fuel oils.

2. <u>THE FIBERS, SYNTHETIC RUBBER AND TIRE INDUSTRIES ARE HIGHLY REGIONALIZED, WHILE THE PLASTICS MATERIALS, PLASTICS PROCESSING AND RUBBER PRODUCTS INDUSTRIES ARE DISTRIBUTED IN THE INDUSTRIAL STATES</u>

- SIC 2821 industry is widely distributed nationally with high concentration in the industrial states, while the major new plants are principally located in the southern half of the United States.

- SIC 2822 plants are principally located in the Gulf Coast area.

- SIC 2823 establishments are primarily in the South Atlantic states.

- SIC 2824 plants in Virginia, North Carolina, South Carolina and Tennessee, account for almost 95% of the industry's energy use.

- The Ohio tire plants of SIC 3011 consume about 25% of the industry's energy, while increased energy needs from expansion is concentrated in the South Central region.

- The plastics and rubber fabrication establishments of SICs 3069 and 3079 are widely distributed nationally with heavier concentration of processors in the East North Central area than other industrialized regions.

3. <u>THE INDUSTRIES STUDIED CAN GENERALLY BE SUBDIVIDED IN TERMS OF MAJOR PROCESSES WITH DISTINCT ENERGY PROFILES</u>

- The major processes of SIC 2821 are electricity use intensive compared to the other processes of the industry and include manufacture of polyethylene, polypropylene, polystyrene and polyvinyl chloride.

- The principal process of SIC 2822 is SBR manufacture, which is significantly less energy intensive than production of the other synthetic rubbers.

- In SIC 2823, acetate fiber manufacture requires more fuels and electricity than that of rayon, and the industry is a heavy user of coal.

- In SIC 2824, nylon and polyester fiber production is less energy intensive than acrylic fibers processes.

- Tire manufacture in SIC 3011 is not characterized by different major processes, although manufacture of radial tires has introduced significant technological modernization.

- In SIC 3021, injection molding of canvas footwear is the most important process, significantly less energy intensive than hand building.

- There are appreciable differences in the energy requirements of the three major techniques for rubber reclaiming in SIC 3031.

- SIC 3069 is not characterized by discrete major processes, although similar equipment is often used to produce widely differing products.

- Extrusion, extrusion blow molding and injection molding are major processes in SIC 3079 and these depend extensively on the use of electricity.

4. THERE ARE NO MAJOR NEAR-TERM (1974) OPPORTUNITIES TO SUBSTITUTE AND CONSERVE PETROLEUM BASED FUELS, BUT IN THE LONG-VIEW (by 1980) APPRECIABLE OPPORTUNITIES MAY EXIST TO SUBSTITUTE COAL FOR OIL OR NATURAL GAS

   - Coal substitution is possible to an appreciable extent in each industry studied except rubber and plastics products fabrication, SICs 3069 and 3079.

   - Substitution is constrained by concerns with air pollution and capital costs, five times greater per unit of capacity for a coal fired steam generator than for one fueled by oil or gas.

- Conservation of fuels and electricity represents an immediate opportunity to reduce energy requirements by less than 5% in the industries studied.
- Flexibility in substituting petroleum based raw materials in the industries studied is probably not appreciable; however, even small improvements in process yields can result in greater savings than accrued from energy conservation.
- Process substitution, where applicable, represents a long-term energy and raw materials conservation opportunity at least because of the new facility installation times required.

5. PROCESS DESIGN IS A PRIME DETERMINANT OF INTRA-INDUSTRY ENERGY EFFICIENCY AND FLEXIBILITY

- Manufacturing facilities are characterized by either single large, relatively efficient production units and/or parallel lines of smaller units; the latter type facilities have greater flexibility in cutting back output when faced with fuel shortages.
- For a given major process, variations in energy efficiency as a function of size and age are generally as significant as variations among differing major processes.
- The industries studied are capital intensive with break even points above 70% for the major processes.

6. SUPPLIES OF FUEL OIL HAVE BEEN GENERALLY ADEQUATE IN THE RUBBER AND PLASTICS INDUSTRIES DURING 1973 AND THE FIRST QUARTER OF 1974

- There is concern with stability in the future availability of fuel oil.
- The concern may be manifested in the long run in reduction, stopping or reversal of the trend in recent years from the use of coal to decreased dependence on oil and gas.

7. **THE PRINCIPAL CONSTRAINT ON PLASTICS AND RUBBER INDUSTRY OPERATIONS DURING 1973 AND THE FIRST QUARTER OF 1974 HAS BEEN SHORTAGES OF PETROLEUM BASED RAW MATERIALS**

- MPAR do not have direct jurisdiction over the oil derived raw materials inputs to the processes of the plastics and rubber industries.

- The principal constraint on industry operations is shortages of raw materials produced from oil derivatives over which MPAR does have direct jurisdiction

- In the industries studied shortages of benzene based materials such as styrene have been particularly serious during 1973 and the first quarter of 1974.

- For 1974, general shortages of about 10% have been projected, with possibly greater shortages of specific items such as styrene, acrylonitrile, neoprene, some resins and plasticizers, etc.

8. **SHORTAGES OF PETROLEUM BASED RAW MATERIALS HAD AN APPRECIABLE ECONOMIC IMPACT ON THE PLASTICS AND RUBBER INDUSTRIES DURING 1973 AND THE FIRST QUARTER OF 1974**

- In the plastics and rubber industries, shortages of raw materials in SIC 2821 impact upon operations in SIC 3079, while SIC 2822 outputs can constrain production in SICs 3011, 3021 and 3069.

- Price increases in raw materials are expected to advance during 1974 at a rate several times that in recent years according to interview respondents.

- The plastics processing industry has experienced declines in employment, while in the other plastics and rubber industries continuation of historical attrition patterns or less than historical gains are expected in 1974.

- The plastics processing industry, SIC 3079, has been impacted most severly.

  - shortages related employment cutbacks of 20,000 to 35,000 from a base of roughly 375,000, representing a 5% to 10% reduction and potentially a temporary phenomenon

  - the expectation of no growth during 1974 in an industry that tripled its volume of output between 1967 and 1973.

- Demand in the noncellulosic man-made fiber industry, SIC 2824, has been strong and a roughly 10% shortfall in supply has been reported.

  - acrylonitrile shortages have been particularly acute

  - nylon intermediates have been in tight supply

  - continued but curtailed growth is expected during 1974.

SECTION III

RECOMMENDATIONS

Based on the findings and conclusions of the study, two recommendations are made, both for near-term action.

Together with Section II, Conclusions, this section serves as a concise executive summary of the key outputs from the study.

1. AS A NEXT PHASE TO THIS STUDY INITIATE A SURVEY OF PETROLEUM BASED RAW MATERIALS USE IN THE PLASTICS AND RUBBER INDUSTRIES

The Snell study concentrated on energy aspects, although much useful information was developed regarding raw materials.

The following tasks are proposed in the next phase:

- Define industry structure (The information is available from this study)
- Define the major processes from the viewpoint of raw materials use (The information is partially available from this study)
- Quantify raw material requirements (The information is partially available from this study)
- Identify plant variations
- Define the supply situation, particularly identifying the status of independent users
- Identify substitutability and conservation opportunities and process tradeoffs
- Identify key constraints on industry operations related to raw materials needs (The information is partially available from this study)

2. INITIATE A STUDY TO DEFINE TECHNICAL OPPORTUNITIES AND STRATEGIES FOR OPTIMIZING PETROLEUM-BASED FUELS AND RAW MATERIALS USE IN THE PLASTICS AND RUBBER INDUSTRIES

The Snell study defined significant variations in the energy intensiveness of many major processes. A similar situation can exist in regard to the use of petroleum based raw materials.

The following tasks are proposed in the study:

- Define and quantify the interrelation of petroleum based fuel dependence with petroleum based raw materials dependence

- Compare in terms of processes, product characteristics, cost and demand, the criticalness of major petroleum derived products or products with significant incorporation of these materials

- Prepare and quantify a list of critical petroleum based raw materials

- Define technical opportunities for optimizing the use of petroleum based raw materials

  - in the near-term

  - in the long-view, through research and development

* * * *

The outputs of the proposed studies should further aid industry as well as government in managing petroleum based materials on a definitive basis.

SECTION IV

SIC 2821, PLASTICS MATERIALS AND RESINS

The 1972 census definition was used for SIC 2821 since output data cited by the Tariff Commission, Society of Plastics Industry "Flashtics", Modern Plastics, etc. correspond significantly more closely to the 1972 census definition and data than to the 1967 census definition. Further, correlation with major product data is more meaningful. Items removed in the 1972 census definition from SIC 2821 were essentially completely transferred to SIC 3079 and thus redefinitions of these two sectors in the 1972 census are accounted for in this study, although an opportunity for refinements exists as the census bridge tables become available. Exhibit IV-1, at the end of this section, presents a detailed definition of this sector.

The most important findings follow regarding the economic impact of the petroleum based materials shortages during 1973 and the first quarter of 1974:

- Fuel shortages were of concern but did not cause serious disruptions
- Raw material shortages were widely claimed with benzene based petrochemicals in particularly short supply
- Employment was not significantly affected, although no appreciable gains were projected for 1974
- No major near-term opportunities for substitution or conservation of fuels were identified
- There are wide differences in the energy efficiency of major processes.

Exhibit IV-2, following Exhibit IV-1, features the Required Tables. These tables and supporting exhibits further define the industry's structure both in economic and energy terms.

All exhibits appear sequentially at the end of this section. Whenever electricity KWHs are expressed at BTUs, conversion is based on the nominal fuel requirements to generate the electricity.

1. MAJOR USES OF FUELS, ENERGY AND PETROLEUM PRODUCTS

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

1.1 Task I, Major Processes

Polymerization is the characteristic method of manufacture in this industry. From simple chemical building blocks (monomers) substances of recurring structural units (polymers) are produced. Polymer facilities can vary according to the following factors:

- The monomer (s) used
- Reaction conditions (time, temperature and pressure)
- Use of solvents and other process chemicals
- Use of suspension or emulsification techniques
- Continuous versus batch operation
- Handling of polymer mass

Exhibit IV-3 presents in matrix form a summary of the polymerization techniques from monomer to processable resin for the five major products included in SIC 2821, low and high density polyethylene (LDPE and HDPE) polypropylene (PP), polyvinyl chloride (PVC), and polystyrene (PS). The manufacture of these five resins represents the major sub-processes of this industry, further discussed under Tasks II and III of this section.

1.2 Task II, Industry Output

Exhibit IV-4 summarizes estimates of the value of overall industry shipments as well as value of shipments by major product and product group for 1967 and 1971-1974. In 1973 the value of all products and services sold by SIC 2821 industry was about $5,300 million.

Exhibit IV-5 summarizes production volume in the same terms. In 1973 total production of SIC 2821 products by SIC 2821 industry was about 21,600 million pounds. Total production by SIC 2821 industry was about 27,200 million equivalent pounds.

Based on the data in Exhibits IV-4 and IV-5, Exhibit IV-2-1 provides the information of Required Table 1.

1.3 Task III, Energy Related Profile Of Major Processes

Energy factors have been estimated for the polymerization processes associated with the major products listed under Task 1.1, above. Exhibit IV-6, summarizes these data.

Required Tables 2, 3, and 4 are presented respectively for LDPE, HDPE, PP, PVC and PS in Exhibits IV-2-2, IV-2-3, and IV-2-4. Series "a" through "e" correspond to each plastic material in these tables.

The major sub-processes discussed above accounted for 57% of the equivalent pounds of resin produced in 1971 as shown on Line 1 of Exhibit IV-5. They accounted for 58% of the total BTUs for the industry reported by census and for 92% of the electrical energy and about 37% of the fuel BTUs. The production of the other resins takes place essentially in jacketed reactors with comparatively low electrical energy requirements for agitation but high fuel requirements for heating and drying.

1.4 Task IV, Shifts In The Energy Related Profile Of The Industry - 1971 To 1973

Exhibit IV-7 summarizes industry level energy factors based on census data and Snell estimates. The 1971 census does not report electricity usage. The energy profiles of the major processes in Exhibits IV-2-2 and 3 were used in conjunction with the product mix of Exhibit IV-8 for 1967, 1971 and 1973 to estimate the electrical requirements. The major processes account for the bulk of electricity used. For 1973 fuel items, extrapolation of the census trend from 1967 to 1971 was used. Based on these data, Exhibit IV-2-5 was prepared, presenting Required Table 5.

The following are extrapolated trends from Exhibit IV-7 regarding fuel shifts from 1971 to 1973 in terms of fuel requirements per equivalent unit of production.

- A decrease in the use of coal (33% reduction per equivalent pound of resin produced)
- A decrease in the use of distillates (39% reduction per pound)
- An increase in the use of residual fuel oil (17% increase per pound)
- While there is a trend showing a 9% decrease in the fuel BTUs required per pound, there was an 11% increase in the electricity requirement per pound.
- The 1% reduction in the BTU equivalents of fuels plus purchased electricity per pound, indicates that extrapolatingfrom the 1967 to 1971 trends is probably reasonable.

The following are observations from Exhibit IV-2-5 regarding shifts in the energy profile of SIC 2821 industry from 1971 to 1973:

- The total BTU requirements of the industry increased about 41%.
- The following energy items increased at a rate above the industry level increase
  - residuals: 65%
  - purchased electricity: 57%
- The following energy items increased at a rate below the industry level increase
  - distillates: 1%
  - coal: 6%
  - natural gas: 38%

1.5 Task V, Projected 1974 Energy Related Profile Of The Industry

Exhibit IV-2-5 also presents the projected energy profile of SIC 2821 for 1974. The profile was developed assuming the same energy factor for 1974 as for 1973, shown in Exhibit IV-7, because product mix and energy efficiency changes between the two years are not expected to be substantial. The factor was applied to the average expected production of 1974, shown in Exhibit IV-5. Use of the 1973 energy factor assumes no significant change in the energy required per unit of production from 1973 to 1974, and a total energy requirement of 235,900 billion BTUs is projected for 1974.

2. GEOGRAPHIC PATTERN OF USE

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

2.1 Task I, Geographic Pattern of the Industry's Energy Related Profile - 1971 to 1973

SIC 2821 establishments are concentrated in the Atlantic and Gulf Coast states plus Ohio, Michigan, Kentucky and California. In general, these are the locations of petroelum refinery complexes which supply the monomers required by the industry for its production processes. The Required Tables in Exhibits IV-2-6, 7, and 8 define the geographic distribution of this industry's energy related profile for 1971 and 1973 based upon the distribution of the value of shipments for these years. With the exception of New York, where energy consumption decreased, energy usage appears to have increased in all states where data was available. In the major manufacturing states, the percentage increase in energy consumption was significantly above the average for all states.

2.2 Task II, Geographic Patterns of Employment and Shipments - 1971 to 1973

Employment and origins of shipments are concentrated in the Atlantic and Gulf Coast states plus Ohio, Michigan, Kentucky and California. The employment distribution according to the 1967 Census definition of the SIC 2821 industry was based upon data from the County Business Patterns and The Bureau of Labor Statistics. This information is presented in Exhibit V-9. This distribution was used to develop the Snell estimates for employment by state for the redefined SIC 2821 industry and to distribute value of shipments. Exhibit IV-2-8 presents the Required Table on employment and shipments.

2.3 Task III, Shifts in the Patterns

With the exception of New York, where employment and energy consumption decreased from 1971 to 1973, increases were observed in all states where information was available. In nearly all major manufacturing states, the percent increases were above the average for all states. At the industry level, the 1971 to 1973 shifts were as follows:

- There was a 60% increase in the value of products and services sold by the SIC 2821 industry (Exhibit IV-4).
- There was a 5% increase in employment.
- There was a 43% increase in the total fuels and energy consumed.

3. FUEL AND ENERGY SUPPLY SITUATION

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings. It should be noted that the data related to the fuel and energy supply situation is illustrative but not representative since the source of information is interviews in a diverse industry with about 800 establishments.

3.1 Task I, "Normal" Stocks Of Materials

Exhibit IV-2-9 presents the "normal" stocks of materials. Snell's telephone survey in this industry determined that all raw materials were available in adequate supply at the end of 1971.

3.2 Task II, Shifts in Stocks

It is apparent from Exhibit IV-2-9 that many raw materials are not available in quantities found before the inception of the shortages.

- Solvents were in short supply during 1973 and the first quarter of 1974.

- Benzene based materials, such as styrene, have been in critically short supply with many plants reporting a "hand-to-mouth" supply situation.

Plants of subsidiaries of oil companies are not affected to the extent that others are since they are assured the fuels and petroleum products that are needed for production.

3.3 Task III, Captive Use

Required Table 10 is not available due to the qualitative nature of the information obtained.

It is unlikely that firms in SIC 2821 produce their own fuel oils. There may be, however, cases where a subsidiary or division of an oil company producing plastic materials obtains fuel from the parent firm.

About 10% of electricity used in the industry is generated in-house. It is doubtful that captive electricity is sold.

3.4 Task IV, Sources of Supply

The sources of supply of fuels include refineries, wholesalers and retailers for fuel oils; mining companies, and wholesalers for coal. Natural gas and electricity are obtained from utilities.

3.5 Task V, Proportion by Type of Supplier

Required Table 11 is not available due to the qualitative nature of information.

3.6 Task VI, Seasonality of Use

Taken as a whole, the industry operated at full capacity year round in 1973. See Exhibit IV-2-12.

4. SUBSTITUTABILITY AND CONSERVATION OF MAJOR FUELS AND PETROLEUM PRODUCTS

The findings under this section were developed through review of secondary sources and review of in-house information as well as interviews with industry sources.

4.1 Task I, Major Processes

In all operations in the industry where coal can be used, there is an opportunity to conserve petroleum based fuels or natural gas by the use of coal. Generally, coal can be a candidate fuel in processes requiring substantial steam.

In "The Plastics Industry In The Year 2000", The Stanford Research Institute reports that

- the still developmental radiation induced polymerization of low density polyethylene requires 25% less energy than the tubular reactor process.

- recent installations for the manufacture of high density polyethylene by the Phillips process require 13% to 25% of the energy input of older ones; the Phillips process accounts for about 60% of HDPE in the U.S.

- the bulk process for polyvinyl chloride requires about 60% less energy than the suspension process; the latter is still predominant.

- the batch suspension process for polystyrene is more energy intensive than continuous mass polymerization.

At the industry level, no significant improvements in energy efficiency are expected in 1974 with respect to 1973, although a less than 5% improvement may be possible through capacity increases, better insulation, operating practices, etc.

4.2 Task II, Quantification of the Major Substitutability and Conservation Opportunities

As shown in Exhibit IV-2-5, coal accounted for about 18% of the industry's total BTUs in 1971, while this has decreased to about 14% in 1973. With the shortages and increasing costs of petroleum based materials a slowing or halting of this trend can be expected. The following are some engineering and economic considerations regarding the use of coal in steam generators in the 100,000 pounds steam per hour range:

- conversion from oil or gas burning to coal burning requires a replacement facility costing $15 to $20 per pound steam per hour.
  - boiler with stoker and fan, $10 to $12 per pound per hour
  - coal handling and storage facilities, $5 to $8 per pound per hour
- a new gas or oil fired package boiler can cost less than $4 per pound steam per hour including fuel handling and storage.
- back conversion to coal of a boiler designed for coal but burning oil or gas can cost $1 to $8 per pound steam per hour, depending on the condition of the retired coal features.

4.3 Task III, Principal Constraints

Principal constraints on the substitution of coal for oil or gas include

- environmental concerns with particulates and sulfur oxides emissions and the cost as well as technological complexity of controlling these.
- the tradeoff of the higher capital cost of coal burning facilities versus long-term prices and availability of oil or gas.

4.4 Task IV, Plant Level Operating Characteristics

Modern polymerization is often carried out under highly controlled conditions of process heat and electricity utilization. Generally, where multiple polymerization lines exist a cutback in fuels and energy can be manifested in shutting down one or more lines. For a single line, cutback in fuels and energy can result in interrupted operations or product of different quality.

The break-even point of the industry varies with each resin. Break-even points of the major processes, polyethylene, polypropylene, polyvinyl chloride and polystyrene are probably at or above about 75% utilization of capacity and depend on pricing. For other resins, break-even points can be in the 25% to 75% capacity utilization range, since generally less capital intensive equipment are involved.

4.5 Task V, Capital Stock (1973)

The 1973 gross book value of fixed assets was roughly $3.5 billion according to the 1972 census redefinition of SIC 2821. The estimate is based on the following:

- The 1971 Annual Survey of Manufactures indicates that the gross book value of fixed assets was $3,759 million in 1971 according to the 1967 census definition of SIC 2821. The 1972 census redefinition reduced the equivalent production in SIC 2821 by approximately 75%. Applying this factor, the gross book value of fixed assets was roughly $2.8 billion in 1971 according to the redefinition.
- According to the 1972 census, MC 72 (P)-28 B-1, capital expenditures were $279 million in the redefined SIC 2821. It is assumed that retirements were minimal.
- Assuming that the approximately 2.5 billion pounds of growth in the equivalent pounds of production by SIC 2821 reflects capacity growth at $0.15 per pound, 1973 capital investment was about $375 million. It is assumed that retirements were minimal.

The average estimated 1973 capital cost is about $0.15 per pound of capacity. The 1973 production by SIC 2821 industry was about 27 billion equivalent pounds. Assuming this represented 85% of capacity utilization, the replacement value of present production capacity is about $4.8 billion.

4.6 Task VI, Planned Capital Investment (1974)

From summarizing data on resin expansion plans from Modern Plastics, February 1973, it is concluded that investment plans for 1974 are about 1.5 times those for 1973, or about $550 million.

4.7 Task VII, Changes to Investment Plans

There is a major growth in capital investment planned for 1974, shown above. Due to the energy crisis, many members of the industry are modifying these plans.

- New construction has slowed down
- Some money originally to be invested in expansion is going into
  - converting plant energy sources from natural gas to oil or from oil to coal when possible
  - paying the cost of improved steam line insulation
  - financing research and development into new, lower energy processes.

It is the study team's judgment that actual 1974 investment will be between the about $375 million expended in 1973 and the about $550 million originally projected for 1974.

5. INTRA-INDUSTRY EFFICIENCY

The findings in this section have been developed through an analysis of industry and in-house data as well as industry interviews.

5.1 Task I, Energy Efficiency

The energy efficiency of the industry has been improving due, for example, to improved designs, the move to larger plants and more sophisticated operating practices. The Conference Board developed the following energy output ratios from census data.

Year	BTUs per 1967 $ of Shipment
1962	52,985
1967	46,044
1975	33,216
1980	26,386

Source: The Conference Board

BTUs per 1967 $ of Shipment consider the BTU content of fuels consumed and that of fuel required to generate the electricity used. A long-term annual industry level improvement of 4% is projected regarding energy efficiency. Considering the general technological trend toward the construction of larger, more efficient plants and assuming continued scarcity of fuel, energy and petroleum based materials, this projection appears reasonable as an upper limit.

The major processes of the industry (polyethylene, polypropylene, polystyrene and polyvinyl chloride) are characterized by large, energy efficient plants. It is shown in Exhibits IV-2-3, "a" through "e", that these are principally users of electricity. Appreciable improvements in their efficiency are not likely, particularly in the near-term. Long-term improvements may be realized through replacement with improved processes.

As a case study in intra-industry efficiency, specific energy data are provided for the manufacture of high density polyethylene in the table below.

Examples of HDPE Process Energy Requirements

Process	Billion BTUs Per Million Lbs HDPE	Source
Phillips	4.1	Society of Plastics Industry
	4.9	Hydrocarbon Processing, November 1973, p. 164 - 172
Stamicarbon	5.5	Industry source quoting a Stanford Research Institute study
Industry Average	6.5	Snell estimate confirmed by limited industry interviews
Solvay (Ziegler)	10.	Industry source quoting a Stanford Research Institute study
Industry High (for older units)	up to 15	Industry sources

Differences in energy requirement as a function of age and size can represent at least a factor of two within a given type of process. Product specification variations can account for a similar factor.

The minor processes of the industry (phenolics, polyester, urea, epoxy, nylon, melamine, etc.) generally rely heavily on the use of fuels. In these plants, heat conservation is a potential area of savings in the near-term. This opportunity to conserve is available for only about 40% of the total energy requirements of the industry.

5.2 Task II, Major Factors Affecting Efficiency

Conservation efforts are not likely to be a major factor affecting energy efficiency in the near-term (1974). Near-term steps are likely to improve the energy efficiency of the industry by less than 5% for the reasons given above.

Interviews with industry representatives indicate the following near-term conservation steps, for example: decrease in office and plant lighting; lowering and locking of thermostats; better insulation of steam lines. In some cases, energy conservation committees have been set up to devise energy saving steps and to insure that these measures are carried out.

6. PRINCIPAL CONSTRAINTS ON CURRENT INDUSTRY OPERATIONS

The findings presented in this section have been obtained through industry interviews and through the analysis of secondary sources and in-house information.

6.1 Task I, Important Constraints

Important potential constraints on the industry's output can be classed in terms of supply related factors and demand related factors.

On the supply side, important determinants are potential fuels, energy and raw materials shortages and capacity limitations. Fuels and energy shortages are not a principal constraint. However, the lack of availability of monomers during 1973 and the first quarter of 1974 has been a serious constraint. For some resins, capacity limitations were also a constraint.

On the demand side, it is generally concluded that plastics processors' requirements have been significantly in excess of supply. A number of sources reported that higher than normal levels of exports of plastics during 1973 have aggravated this situation.

6.1.1 Raw Materials and Production Capacity

The table below summarizes the monomer availability and capacity restrictions related situation for several important products of SIC 2821 industry.

Plastics	End-of-Year 1973 Raw Materials and Production Capacity Status
Polyvinyl Chloride	Production was mostly monomer and somewhat plant capacity restricted and should be the same in '74 as in '73.
Polystyrene	Production was limited by benzene and ethylene dependence. Plant capacity was available.
Polyethylene	Production was limited by plant capacity and ethylene dependence. The new plants that will come on stream in '74 and '75 will add about 18% to capacity.
ABS	Production was limited by ethylene and benzene dependence.

Plastics	End-of-Year 1973 Raw Materials and Production Capacity Status
Nylon	Nylon 6 was cut back approximately 80%, due to benzene dependence. DuPont is bringing on new Nylon 6/6 capacity in '75 to increase production 40%.
Acrylics	Acrylics were on allocation because of acetone dependence. Curtailment was about 90% . This situation is expected to improve as results of the Shell fire disappear.
Phenolics	Phenolics production was generally at a 60% level because of benzene dependence.

Source: Massachusetts Department of Commerce and Development, SPI, industry sources and Snell.

The table illustrates the benzene dependence of SIC 2821 industry.

6.1.2 Availability of Benzene Based Materials

Recent FEO action may result in a significant increase in the availability of benzene based materials, according to DeWitt and Company.

- The new February 25 regulations permit aromatics producers to increase benzene prices by 33.7 cents per gallon and toluene prices by 28.8 cents per gallon. The reduction required in the pass-through of feedstock cost to prices of other covered products has been dropped to 20 cents per gallon benzene and toluene, multiplied by May, 1973 sales of benzene and toluene rather than current production.

- Thus, the producer gets the full benefit of the price increase permitted, which should make benzene and toluene recovery more attractive than leaving them in gasoline, where there has been no major change in price controls.

- While these new regulations will increase benzene producers' profits and stimulate new production, they should not affect the trends in pricing already established by the January 31 regulations.

- The new regulations do not restrict benzene exports in terms of price or allocation.

  - Exports of most other petroleum products have been cut back by quotas imposed by the Department of Commerce, rather than by any action of the FEO.

  - Legislation has been introduced to restrict exports of those petrochemicals still under price controls, but no action in the near future is likely.

Despite the fact that this relaxation in controls will ease the benzene supply situation, it is important to realize that benzene production capacity is limited. In the near term, this capacity restriction will impose a new limit on the supply of benzene.

6.1.3 Exports

The table below shows that exports in 1973 increased over 1972. The change in exports was considerably higher than the production increase for low density polyethylene, polypropylene and polystyrene.

Million Lbs.

Commodity	Production 12 Months Jan.-Dec. 1973	1972	73/72	Export 12 Months Jan.-Dec. 1973	1972	73/72
PLASTIC MATERIALS						
Polyethylene, high density	2,612	2,341	+ 11	292	292	-
Polyethylene, low density	5,839	5,288	+ 10	500	395	+ 27
Polypropylene	2,152	1,732	+ 24	318	165	+ 93
Polystyrene	3,968 E	3,560 E	+ 11	212	156	+ 36
ABS & SAN	990 E	910 E	+ 9	38	38	-
Polyvinyl chloride	4,423	4,289	+ 3	162	158	+ 3

E = Estimated

Source: Department of Commerce

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6.1.4 Price Trends

Price trends in basic materials and feedstocks will naturally manifest themselves in the ultimate prices of the final plastics materials which are expected to increase dramatically during the next five years. A major portion of the price increase is expected to take place in the near term, as prices adjust themselves to the new supply-demand relationships.

6.2 Task II, Most Serious Constraint

The most serious constraint is probably raw material shortages. A number of interview respondents expect significant easing during the latter half of 1974. The projected increased supply of benzene related materials and increased oil imports is expected to lessen the shortages. The effects of a recession would be similar.

6.3 Task III, Shortfalls in Supply and Price Increases

Industry sources indicated that during the first quarter of 1974 a 5% to 8% overall shortage occurred in SIC 2821 products with respect to demand, with benzene-based polymers experiencing the greatest shortfall.

The table below indicates price increases for some high volume plastics during the first quarter of 1974.

	Quotes, $				
Commodity	End December 1973		End April 1974		Percent Change (1)
Polyethylene resin, low density, film liner, hopper cars, frt alld. lb.	.13	.14	.16-1/2	.18-1/2	32
clarity film, hopper cars, frt., alld. ....lb.	.14-1/2	-	.184-1/2	.19	31
garment film, hopper cars, same basis ....lb.	.14-1/2	.15	.18	.19	27
pallet shrink film, hopper cars, same basis...............lb.	.14	-	.18	.19	36
extrusion coating, hopper cars, same basis ....lb.	.12-1/2	.13-1/2	.17	.18	33
molding, g.p., hopper cars, same basis ....lb.	.13	-	.18-1/2	.19-3/4	52

(1) Percent Change based on high quotes where applicable.

Commodity	End December 1973		End April 1974		Percent[(1)] Change
injection molding, g.p., hopper cars, same basis ....lb.	.13	.15-3/4	.16-3/4	.19	25
rotational molding, g.p., hopper cars, same basis ....lb.	.15-3/4	.20	No Prices		
Polyethylene resin, high density, blow molding, g.p., hopper cars, frt. alld. ....lb.	.13-1/2	.15	.16-1/2	.19-1/2	30
injection molding, g.p., hopper cars, same basis, frt. alld. lb.	.13-1/2	.14-1/2	.17	.21-1/2	48
extrusion, g.p., hopper cars, same basis, frt. alld......lb.	.13-1/2	.14-1/2	.17	.21-1/2	48
Polypropylene resin, g.p. homopolymer, nat. t.l., frt. alld...lb.	.17	-	.19	.22	29
copolymer, med. impact, nat., same basis ....lb.	.22	-	.23	.28	27
copolymer, high impact, nat., same basis ....lb.	.24	-	.25	.28	17
food grade, nat., same basis ..lb.	.17	-	.19	-	12

Note: Colored material is 6¢ per lb. higher for each of the quoted grades

Commodity	End December 1973		End April 1974		Percent[(1)] Change
Polystyrene resin, cryst., nat., hopper cars, frt., alld. ....lb.	.13	.14	.24-1/2	.26	86
med. impact, nat., hopper cars, same basis ....lb.	.15-1/2	.18	.25-1/2	.28	56
high impact, nat., hopper cars, same basis ....lb.	.16-1/2	.19	.26-1/2	.29	53
high heat, high impact, nat., hopper cars, same basis ......lb.	.17-1/2	.18-1/2	.27-1/2	.29	57
Polyvinyl chloride resin, g.p. homopolymer dispersion, bgs., t.l., frt. alld.................lb.	.23	.24	.27	.30	25
g.p. copolymer dispersion, same basis ....lb.	.24	.25	.27	.32	28
g.p. suspension, bulk, same basis ....lb.	.13	.13	.17	.18	39
g.p. copolymer suspension, same basis ....lb.	.13	.14	.17-1/2	.20	43

Source: Chemical Marketing Reporter

Price increases, according to some sources, will cause re-examination of the uses of plastic materials. A shift away from convenience to necessity in application is expected to result in selective demand for these materials.

6.4 Task IV, Outputs Critical to Subsequent Production

The products of this industry are critical in the U.S. economy. After processing, as represented by the manufacturing operations under SIC 3079, plastics and resins are consumed according to the following pattern.

Market	Percent Consumption of Plastics in 1970
Building and construction	24
Packaging	27
Transportation	10
Electric/electronics	9
Furniture	4
Housewares	5
Appliances	3
Other	18
Total	100

End-uses in the "Other" category include toys, textile and paper treating, agriculture, marine craft, signs, shoes and phonograph records.

Source: Modern Plastics, July 1973, p. 100 and Snell estimates.

EXHIBIT IV-1 (1)
FEO: USDC
DEFINITION OF SIC 2821

SIC 2821 PLASTICS MATERIALS, SYNTHETIC RESINS, AND NONVULCANIZABLE ELASTOMERS

Establishments primarily engaged in manufacturing synthetic resins, plastics materials, and nonvulcanizable elastomers. Important products of this industry include: cellulose plastic materials; phenolic and other tar acid resins; urea and melamine resins; vinyl resins; styrene resins; alkyd resins; acrylic resins; polyethylene resins; polypropylene resins; rosin modified resins; coumarone-indene and petroleum polymer resins; and miscellaneous resins including polyamide resins, silicones, polyisobutylenes, polyesters, polycarbonate resins, acetal resins, fluorohydrocarbon resins; and casein plastics. Establishments primarily engaged in manufacturing fabricated plastics products or plastics film, sheet, rod, nontextile monofilaments and regenerated cellulose products, and vulcanized fiber are classified in Industry 3079, whether from purchased resins or from resins produced in the same plant. Establishments primarily engaged in compounding purchased resins are also classified in Industry 3079. Establishments primarily manufacturing adhesives are classified in Industry 2891.

Acetal resins
Acetate, cellulose (plastics)
Acrylic resins
Acrylonitrile-butadiene-styrene resins
Alcohol resins, polyvinyl
Alkyd resins
Allyl resins
Butadiene copolymers, containing less than 50% butadiene
Carbohydrate plastics
Casein plastics
Cellulose nitrate resins
Cellulose propionate (plastics)
Coal tar resins
Condensation plastics
Coumarone-indene resins
Cresol-furfural resins
Cresol resins
Dicyandiamine resins
Diisocyanate resins
Elastomers, nonvulcanizable (plastics)
Epichlorohydrin bisphenol
Epichlorohydrin diphenol
Epoxy resins
Ester gum
Ethyl cellulose plastics
Ethylene-vinyl acetate resins
Fluorohydrocarbon resins
Ion exchange resins
Ionomer resins
Isobutylene polymers
Lignin plastics
Melamine resins
Methyl acrylate resins
Methyl cellulose plastics
Methyl methacrylate resins
Molding compounds, plastics
Nitrocellulose plastics (pyroxylin)
Nylon resins
Petroleum polymer resins
Phenol-furfural resins
Phenolic resins
Phenoxy resins
Phthalic alkyd resins
Phthalic anhydride resins
Polyacrylonitrile resins
Polyamide resins
Polycarbonate resins

EXHIBIT IV-1 (2)
REF: USDC
DEFINITION OF SIC 2821

Polyesters
Polyethylene resins
Polyhexamethylenediamine adipamide resins
Polyisobutylenes
Polymerization plastics, except fibers
Polypropylene resins
Polystyrene resins
Polyurethane resins
Polyvinyl chloride resins
Polyvinyl halide resins
Polyvinyl resins
Protein plastics
Pyroxylin
Resins, phenolic
Resins, synthetic: coal tar and non-coal tar
Rosin modified resins
Silicone fluid solution (fluid for sonar transducers)
Silicone resins
Soybean plastics
Styrene resins
Styrene-acrylonitrile resins
Tar acid resins
Urea resins
Vinyl resins

Source: 1972 Standard Industrial Classification Manual

EXHIBIT IV-2-1
FEO:USDC
REQUIRED TABLE 1

Proportion of Industry Output Accounted for by Each Major Process, 1973

SIC 2821 Industry Plastics Materials and Resins

Process and Major Products	Percent of 1973 Shipments Value	Percent of 1973 Production Volume 1/
Thermoplastics Resins	64.0%	65.0%
Low-density polyethylene	11.0	16.9
High-density polyethylene	5.1	7.6
Polypropylene	5.6	6.3
PVC	9.6	13.3
Polystyrene	8.5	9.5
Other	24.2	11.4
Thermosetting resins	15.5	14.5
Secondary products and miscellaneous services	20.5	20.5
Total Industry (Percent)	100.0	100.0
(Actual)	$ 5,303,800,000	27,185,000,000

1/ Production volume expressed in pounds

Source: Exhibits IV-4 and IV-5.

EXHIBIT IV-2-2a
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume, 1971 and 1973(1)

SIC 2821 Industry Plastics Materials and Resins

Process Low Density Polyethylene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total Ethylene	million lbs.		3,700				4,800		
6	Petroleum products, total									
7	Coal		(NA)			(NA)	(NA)			(NA)
8	Natural gas									
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	2,100			2,100	2,700			2,700
12	GRAND TOTAL									

Source: (1) Figures obtained by multiplying the production data of Exhibit IV-5 by the energy factors of Exhibit IV-6.

EXHIBIT IV-2-3a
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billions BTUs, 1971 and 1973

SIC 2821 Industry Plastics Materials and Resins

Process Low Density Polyethylene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion BTUs	18,300			18,300	23,700			23,700
9	Fuels, n.e.c., total									
10	Other fuels, total									28,200
11	Electrical energy (purchased)	billion BTUs	21,900			21,900	28,200			51,900
						40,200				
12	GRAND TOTAL	billion BTUs								

EXHIBIT IV-2-4a
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalents, 1971 and 1973

SIC 2821 Industry Plastics Materials and Resins

Process Low Density Polyethylene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	million KWH	5,400			5,400	6,900			6,900
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)(1)	million KWH	6,400			6,400	8,200			8,200
12	GRAND TOTAL	million KWH				11,800				15,100

(1) KWH of electricity times 3.1 to express as fuel equivalents

EXHIBIT IV-2-2b
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume, 1971 and 1973 (1)

SIC 2821 Industry Plastics Materials and Resins

Process High Density Polyethylene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
	Ethylene	million lbs		1,560				2,200		
6	Petroleum products, total									
7	Coal									
8	Natural gas		(NA)			(NA)	(NA)			(NA)
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	600			600	810			810
12	GRAND TOTAL									

Source: (1) Figures obtained by multiplying the production data of Exhibit IV-5 by the energy factors of Exhibit IV-6.

EXHIBIT IV-2-3b
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in BTUs, 1971 and 1973

SIC 2821 Industry Plastics Materials and Resins

Process High Density Polyethylene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6 7 8 9	Petroleum products, total Coal Natural gas Fuels, n.e.c., total	billion BTUs	3,400			3,400	4,800			4,800
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTUs	6,300			6,300	8,700			8,700
12	GRAND TOTAL	billion BTUs				9,700				13,500

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalents, 1971 and 1973

SIC 2821 Industry Plastics Materials and Resins

Process High Density Polyethylene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	million KWH	1,000			1,000	1,400			1,400
8	Natural gas									
9	Fuels, n.e.c., total									
10	Other fuels, total					1,800	2,500			2,500
11	Electrical energy (purchased) (1)	million KWH	1,800							
12	GRAND TOTAL	million KWH				2,800				3,900

(1) KWH of electricity times 3.1 to express as fuel equivalents.

EXHIBIT IV-2-2c
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume, 1971 and 1973 (1)

SIC 2821 Industry Plastics Materials and Resins

Process Polystyrene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
	Styrene	million lbs.		2,400				2,800		
6	Petroleum products, total									
7	Coal									
8	Natural gas		(NA)			(NA)	(NA)			(NA)
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	380			380	440			440
12	GRAND TOTAL									

Source: (1) Figures obtained by multiplying the production data of Exhibit IV-5 by the energy factors of Exhibit IV-6.

EXHIBIT IV-2-3c
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billions BTUs, 1971 and 1973

SIC 2821 Industry Plastics Materials and Resins

Process Polystyrene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total	billion BTUs	3,400			3,400	4,000			4,000
7	Coal									
8	Natural gas									
9	Fuels, n.e.c., total									
10	Other fuels, total	billion BTUs	4,000			4,000	4,700			4,700
11	Electrical energy (purchased)									
12	GRAND TOTAL	billion BTUs				7,400				8,700

EXHIBIT IV-2-4c
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalents, 1971 and 1973

SIC 2821 Industry Plastics Materials and Resins

Process Polystyrene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	million KWH	1,000			1,000	1,200			1,200
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)(1)	million KWH	1,200			1,200	1,400			1,400
12	= GRAND TOTAL	million KWH				2,200				2,600

(1) KWH of electricity times 3.1 to express as fuel equivalents.

EXHIBIT IV-2-2d
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Volume(1)

SIC 2821 Industry Plastics Materials and Resins

Process Polypropylene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
	Propylene	million lbs.		1,100				1,800		
6	Petroleum products, total									
7	Coal		(NA)			(NA)	(NA)			(NA)
8	Natural gas									
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	420			420	680			680
12	GRAND TOTAL									

Source: (1) Figures obtained by multiplying the production data of Exhibit IV-5 by the energy factors of Exhibit IV-6.

EXHIBIT IV-2-3d
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in BTU s, 1971 and 1973

SIC 2821 Industry Plastics Materials and Resins

Process Polypropylene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion BTU s	1,800			1,800	2,900			2,900
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTU s	3,600			3,600	5,800			5,800
12	GRAND TOTAL					5,400				8,700

EXHIBIT -2-4d
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalents

SIC 2821 Industry Plastics Materials and Resins

Process Polypropylene

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	million KWH	500			500	800			800
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)(1)	million KWH equivalents	1,000			1,000	1,700			1,700
12	GRAND TOTAL					1,500				2,500

(1) KWH of electricity times 3.1 to express as fuel equivalents.

EXHIBIT IV-2-2e
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Volume.(1)

SIC 2821 Industry Plastics Materials and Resins

Process Polyvinyl Chloride

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
	Vinyl chloride	million lbs.		2,800				3,700		
6	Petroleum products, total									
7	Coal									
8	Natural gas		(NA)			(NA)	(NA)			(NA)
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	2,300			2,300	3,000			3,000
12	GRAND TOTAL									

Source: (1) Figures obtained by multiplying the production data of Exhibit IV-5 by the energy factors of Exhibit IV-6.

EXHIBIT IV-2-3e
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billions BTUs.

SIC 2821 Industry Plastics Materials and Resins

Process Polyvinyl Chloride

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion BTUs	7,300			7,300	9,700			9,700
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTUs	24,200			24,200	32,200			32,200
12	GRAND TOTAL	billion BTUs				31,500				41,900

EXHIBIT IV-2-4e
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Million KWH.

SIC 2821 Industry Plastics Materials and Resins

Process Polyvinyl Chloride

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1 2 3 4	Propane, butane and mixtures Middle distillates Residual fuel oil Chemical feedstocks	million KWH								
5	Other petroleum products, total									
6 7 8 9	Petroleum products, total Coal Natural gas Fuels, n.e.c., total	million KWH	2,100			2,100	2,800			2,800
10 11	Other fuels, total Electrical energy(1) (purchased)	million KWH	7,100			7,100	9,400			9,400
12	GRAND TOTAL	million KWH				9,200				12,200

(1) KWH of electricity times 3.1 to express as fuel equivalents.

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EXHIBIT IV-2-5
FEO: USDC
REQUIRED TABLE 5

Industry Consumption of Fuels, Petroleum Products, and Energy by Type - 1971, 1973, and 1974

SIC 2821 Industry Plastics Materials and Resins

(Reflecting the 1972 Census redefinition of the industry)

Line No.	Type of Energy or Material	Unit of Measure	Volume (1) 1971	Volume (1) 1973	Volume (1) 1974	(Bil. BTU s)* 1971	(Bil. BTU s)* 1973	(Bil. BTU s)* 1974	% Change 1971-73	% Change 1973-74	% of Total BTU s 1971	% of Total BTU s 1974
1	Propane, butane, and mixtures											
2	Middle distillates	1,000 barrels	1,214	1,231	1,315	7,072	7,171	7,660	1.4	6.8	4.5	3.2
3	Residual fuel oil	1,000 barrels	2,471	4,080	4,356	15,535	25,651	27,386	65.1	6.3	9.9	11.6
4	Chemical feedstocks											
5	Other petroleum, products, total . Extender oils(2)	million dollars	5.2	7.3								
6	Petroleum products, total											
7	Coal	1,000 short tons	1,071	1,139	1,216	28,060	29,843	31,860	6.4	6.8	17.9	13.5
8	Natural gas	billion cu. ft.	39.4	54.4	58.0	40,661	56,141	59,856	38.1	6.6	26.0	25.4
9	Fuels, n.e.c. total											
10	Other fuels, total											
11	Electrical energy (purchased only)	million KWH	6,154	9,787	10,448	65,196	102,216	109,126	56.8	6.8	41.7	46.3
12	GRAND TOTAL Lines 6, 7, 8, 10		(X)	(X)	(X)	156,600	221,000	235,900	41	6.7	100%	100%

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Source: (1) Respective energy factors in Exhibit IV-7 times total production on Line 1, Exhibit IV-5. For 1974 the average of the "Low" and "High" is used and the 1973 energy factor is used.
(2) Although this study deals with industrial energy use, dollar volume data is provided on extender oils, since these are directly subject to the Mandatory Petroleum Allocation Regulations. Estimates are based on census "Materials Consumed" for 1972 from MC72 (P) - 28B-1 and Line 1 production data from Exhibit IV-5.

EXHIBIT IV-2-6a
FEO:USDC
REQUIRED TABLE 6

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit(1)

SIC 2821 Industry Plastics Materials and Resins Year 1971

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Bil. Total (~~Mil.~~ BTU s)	Other Fuels: Coal (Thousand Short Tons)	Bil. Natural Gas (~~Mil.~~ Cu. Ft.)	Bil. Fuels, n.e.c. (~~Mil.~~ BTU s)	Bil. Total (~~Mil.~~ BTU s)	Bil. Purchased Electrical Energy (~~Mil.~~ BTU s)	Bil. Grand Total (~~Mil.~~ BTU s)
1	United States		1,214	2,471			22,600	1,071	39.4		68,700	65,200	156,600
2	NORTH EAST		380	830			7,400	340	4.1		21,300	20,860	46,700
3	New England		110	240			2,100	100	3.7		6,200	5,900	14,200
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.		85	1,600			1,500	140	.5		9,100	4,100	10,000
8	R.I.												
9	Conn.												
10	Middle Atlantic		270	590			5,300	240	.4		15,600	14,900	35,500
11	N.Y.		50	100			900	40	1.5		2,500	2,400	5,700
12	N.J.		110	240			2,100	100	3.7		6,200	5,900	14,200
13	Penn.		140	300			2,700	120	4.7		7,900	7,600	18,000
14	NORTH CENTRAL		320	690			6,200	270	11.1		18,400	17,500	41,700
15	E. North Central		270	590			5,300	240	9.4		15,600	14,900	35,500
16	Ohio		100	200			1,900	80	3.4		5,600	5,300	12,800
17	Ind.		50	100			900	40	1.7		2,800	2,600	6,200
18	Ill.												
19	Mich.												
20	Wisc.												
21	W. North Central		50	100			900	30	1.7		2,800	2,600	6,200
22	Minn.												
23	Iowa												
24	Mis.												
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Bil. Total (Mil. BTU s)	Other Fuels: Coal (Thousand Short Tons)	Bil. Natural Gas (Mil. Cu. Ft.)	Bil. Fuels, n.e.c. (Mil. BTU s)	Bil. Total (Mil. BTU s)	Bil. Purchased Electrical Energy (Mil. BTU s)	Bil. Grand Total (Bil. BTU s)
29	SOUTH		510	950			8,200	870	14.4		24,000	23,000	54,[illegible]
30	S. Atlantic		220	370			3,600	160	3.4		10,600	10,200	24,[illegible]
31	Del.												
32	Md.												
33	D.C.												
34	Va.												
35	W. Va.												
36	N.C.												
37	S. C.												
38	Ga.												
39	Fla.												
40	S.Central		290	480			4,700	210	8.2		13,700	13,000	31,200
41	Ky		50	80			800	30	1.4		2,300	2,100	5,100
42	Tenn.												
43	Ala.												
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas		100	210			1,900	80	3.4		5,600	5,300	12,800
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

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EXHIBIT IV-2-6c

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Bil. Total (~~Mil.~~ BTU s)	Other Fuels: Coal (Thousand Short Tons)	Bil. Natural Gas (~~Mil.~~ Cu. Ft.)	Bil. Fuels n.e.c. (~~Mil.~~ BTU s)	Bil. Total (~~Mil.~~ BTU s)	Bil. Purchased Electrical Energy (~~Mil.~~ BTU s)	Bil. Grand Total (~~Mil.~~ BTU s)
59.	Pacific		90	170			1,600	70	2.9		4,300	4,100	10,800
60	Wash.												
61	Ore.												
62	Cal.		80	160			1,500	70	2.6		4,400	4,500	10,000
63	Alas.												
64	Haw.												

Source: (1) Using the geographic BTU distribution for Exhibit IV-2-8 and the national distribution of fuel, petroleum products and energy type from Exhibit IV-2-5. Exhibit IV-2-8 indicates geographic units where plastics industry is located and for which data is not available.

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit

SIC 2821 Industry Plastics Materials and Resins Year 1973

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)	Fuels, n.e.c. (Bil. BTUs)	Total (Bil. BTU s)	Purchased Electrical Energy (Bil. BTU s)	Grand Total (Bil. (BTU s)
1	United States		1,231	4,080			32,300	1,139	54.4		36,000	102,200	221,000
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.		85	270			2,200	80	3.7		5,700	6,300	14,700
8	R.I.												
9	Conn.												
10	Middle Atlantic												
11	N.Y.		30	95			800	30	1.4		2,100	2,500	5,400
12	N.J.		140	450			3,600	130	6.0		9,400	10,900	23,900
13	Penn.												
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio		120	380			3,100	110	5.3		8,100	9,600	21,000
17	Ind.												
18	Ill.												
19	Mich.												
20	Wisc.												
21	W. North Central												
22	Minn.												
23	Iowa												
24	Mis.												
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Bil. Total (~~Mil.~~ BTU's)	Other Fuels: Coal (Thousand Short Tons)	Bil. Natural Gas (~~Mil.~~ Cu. Ft.)	Fuels, n.e.c. (Mil. BTU's)	Bil. Total (~~Mil.~~ BTU's)	Bil. Purchased Electrical Energy (~~Mil.~~ BTU's)	Bil. Grand Total (~~Mil.~~ BTU's)
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.												
33	D.C.												
34	Va.												
35	W. Va.												
36	N.C.												
37	S. C.												
38	Ga.												
39	Fla.												
40	S. Central												
41	Ky												
42	Tenn.												
43	Ala.												
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas		120	370			3,000	100	5.1		7,300	9,300	20,200
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Bil. Total (~~Mil.~~ BTU s)	Other Fuels: Coal (Thousand Short Tons)	Bil. Natural Gas (~~Mil.~~ Cu. Ft.)	Fuels n.e.c. (Mil. BTU s)	Bil. Total (~~Mil.~~ BTU s)	Purchased Electrical Energy Bil. (~~Mil.~~ BTU s)	Bil. Grand Total (~~Mil.~~ BTU s)
59	Pacific												
60	Wash.												
61	Ore.												
62	Cal.		85	300			2,400	80	4.0		6,200	7,[illegible]	16,000
63	Alas.												
64	Haw.												

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Shipments, Employment, and Fuels and Energy Consumed by Geographic Unit, 1971 and 1973

SIC 2821 Industry Plastics Materials and Resins

(Reflecting the 1972 Census Redefinition of the Industry)

Line Number	Geographic Unit	Value of Shipments(1) ($ Millions) 1971	1973(2)	% Change	Employment(1) 1971	1973	% Change	Fuels and Energy(3) (Bil. BTUs)* 1971	1973	% Change
1	United States	3,320	5,300	59.6	56,360	59,910	5.4	156,600	221,[illegible]00	41
2	NORTH EAST	1,050	(NA)	(NA)	15,760	15,690	(0.4)	49,700	(NA)	(NA)
3	New England	300	(NA)					14,200	(NA)	(NA)
4	Maine	-								
5	N.H.	(NA)								
6	Vermont	(NA)								
7	Mass.	210	350	67	4,610	5,680	10.4	10,000	14,700	47
8	R.I.	(NA)								
9	Conn.	(NA)								
10	Middle Atlantic	750	(NA)					35,500	(NA)	(NA)
11	N.Y.	120	130	8	3,400	3,060	(10.0)	5,700	5,400	(5)
12	N.J.	300	570	90	6,890	7,560	9.8	14,200	23,900	68
13	Penn.	380	(NA)					18,000	(NA)	(NA)
14	NORTH CENTRAL	880	(NA)					41,700	(NA)	(NA)
15	E. North Central	750	(NA)					35,500	(NA)	(NA)
16	Ohio	270	500	85	3,570	3,900	9.2	12,800	21,000	64
17	Ind.	(NA)								
18	Ill.	130	(NA)					6,200	(NA)	(NA)
19	Mich.	(NA)			2,910	3,250	11.7	(NA)		
20	Wisc.	(NA)			1,030	(NA)				
21	W. North Central	130	(NA)					6,200	(NA)	(NA)
22	Minn.	(NA)			420	520	24.8	(NA)		
23	Iowa	(NA)								
24	Mis.	(NA)								
25	N.D.	-			-	-	-			
26	S.D.	-			-	-	-			
27	Neb.	(NA)								
28	Kans.	-			-	-	-			

*BTUs & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

(Reflecting the 1972 Census Redefinition of the Industry)

Line Number	Geographic Unit	Value of Shipments(1) ($ Millions)			Employment(1)			Fuels and Energy(3) (Bil. BTUs)*		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
29	SOUTH	1,160	(NA)					54,800	(NA)	(NA)
30	S. Atlantic	510	(NA)					24,100	(NA)	(NA)
31	Del.	(NA)			1,270	1,330	4.9			
32	Md.	(NA)								
33	D.C.	-								
34	Va.	(NA)								
35	W. Va.	(NA)								
36	N.C.	(NA)								
37	S.C.	(NA)								
38	Ga.	(NA)								
39	Fla.	(NA)								
40	S. Central	660	(NA)					31,200	(NA)	(NA)
41	Ky.	(NA)			1,080	1,280	19.2	(NA)		
42	Tenn.	110	(NA)					5,100	(NA)	(NA)
43	Ala.	-								
44	Miss.	(NA)								
45	Ark.	(NA)			100	(NA)				
46	La.	(NA)			1,450	1,340	(7.9)	(NA)		
47	Okla.	(NA)				220	(NA)			
48	Texas	270	480	78	2,990	3,190	6.7	12,800	20,200	58
49	WEST	(NA)								
50	Mountain	(2)								
51	Mont.									
52	Idaho									
53	Wyo.									
54	Colo.									
55	N.M.									
56	Ariz.									
57	Utah									
58	Nev.									

*BTUs & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

(Reflecting the 1972 Census Redefinition of the Industry)

Line Number	Geographic Unit	Value of Shipments(1) ($ Millions) 1971	1973	% Change	Employment(1) 1971	1973	% Change	Fuels and Energy(3) (Bil. BTUs)* 1971	1973	% Change
59	Pacific	230	(NA)					10,800	(NA)	(NA)
60	Wash.	(NA)								
61	Ore.	(NA)								
62	Cal.	210	380	81	2,850	3,070	7.8	10,000	16,000	60
63	Alas.	-								
64	Haw.	(T)								

*BTUs & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Source: (1) Based on the estimates of Exhibit IV-9 scaled by applying the ratio of the 1971 change in the U.S. total value of shipments due to the redefinition of the industry. The ratio is $3.32 billion to $4.40 billion.

(2) Snell estimates accounting for average price increases, productivity improvement and employment changes.

(3) U.S. figures from line 12, Exhibit IV-2-5. Remaining figures are estimated by applying the line 12 energy factors from Exhibit IV-7 to the average equivalent production represented by distribution of value of shipments in left-hand columns of this table.

EXHIBIT IV-2-9
FEO: USDC
REQUIRED TABLE 9

Stocks of Fuels and Petroleum Products by Type, 12/31/73 and 3/31/74

SIC 2821 Industry Plastics Materials and Resins

Line Number	Type of Energy or Material	Stocks (# of days supply related to average daily requirements in next quarter)					
		As of December 31			As of March 31		
		1971	1972	1973	1972	1973	1974
1	Propane (x)						
2	Butane (x)						
3	Propane Butane Mixture (x)						
4	Middle Distillates	7-30	(NA)	7-30	(NA)	(NA)	7-14
5	Residual Fuel Oil	7-30	(NA)	7-30	(NA)	(NA)	7-14
6	Chemical Feedstocks (x)						
7	Other Petroleum Products						
	. Monomers						
	- Syrene	7-30	(NA)	7	(NA)	(NA)	1-4
	- Phenol	(NA)	(NA)	7	(NA)	(NA)	1-2
	- Ethylene Glycol	(NA)	(NA)	14	(NA)	(NA)	10
	- Vinyl Acetate	30	(NA)	14	(NA)	(NA)	10
	- Esters	7	(NA)	3	(NA)	(NA)	3
	. Solvents						
	- Acetone	30	(NA)	30	(NA)	(NA)	0-1
	- MEK	7-30	(NA)	2-3	(NA)	(NA)	0-1
8	Coal	30	30	30	30	30	30
9	Natural Gas (2)(x)						
10	Fuels, n.e.c., total						

Source: (1) Illustrative but statistically not significant values obtained from industry interviews
(2) Natural gas is from pipeline, with many users on interruptable supply during winter months. No appreciable interruptions were reported for the winter of 1973.

EXHIBIT IV-2-12
FEO: USDC
REQUIRED TABLE 12

Seasonal Use of Fuels, Petroleum Products and Energy by Type, 1973

SIC 2821 Industry Plastics Materials and Resins

Line Number	Type of Material or Energy	Percent of Annual Use in 1973 in (1) Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.
1	Propane, butanes and mixtures (X)				
2	Distillates	30%	20%	20%	30%
3	Residual	30	20	20	30
4	Feedstocks (X)				
5	Other petroleum products				
6	Coal	25	25	25	25
7	Natural gas	20	30	30	20
8	Other fuels (X)				
9	Electrical Energy (purchased)	25	25	25	25

Source: Illustrative but statistically not significant values obtained from industry interviews.

EXHIBIT IV-3
FEO: USDC
POLYMERIZATION TECHNIQUES FOR MAJOR
SIC 2821 RESINS

Factors	LDPE	HDPE	PP	PVC	PS/HIPS[2]
Monomer[1]	Ethylene	Ethylene	Propylene	Vinyl chloride	Styrene
Reaction Conditions					
Time	Seconds	1-3 hours	(NA)	(NA)	3-1/2 - 6-1/2 hours
Temperature	150-300°C	125-175°C	35-95°C	45-55°C	110-170°C (solution) 90-115°C (suspension)
Pressure	1,000-3,000 atm	20-30 atm	$<$15 atm	(NA)	1-10 atm
Process Chemicals					
Solvent	(X)	Hydrocarbon	Hydrocarbon	(X)	Ethyl benzene
Catalyst	Organic peroxides	Metallic salts	Metallic salts	Peroxide	Peroxide
Other	(X)	(Z)	(Z)	(X)	Calcium phosphate (as buffer)
Dispersion Technique	(X)	Solution or slurry	Solution or slurry	Suspension or emulsion	Solution or suspension
Production Technique	Continuous	Continuous or Batch	Continuous or Batch	Batch	Continuous
Handling of Polymer	Ethylene evaporated from slurry and polymer extruded into pellets	Solvent evaporated from polymer solution or slurry and polymer extruded into pellets	Slurry washed and polymer centrifuged, dried, and extruded into pellets	Monomer flashed off and polymer centrifuged and dried	Solvent or monomer flashed off and polymer devolatilized and extruded into pellets

Source: Snell

(1) Plus other monomers/polymers for the production of certain copolymers.
(2) Normal polystyrene (PS) and high impact polystyrene (HIPS).

EXHIBIT IV-4

FEO:USDG

SIC 2821 - VALUE OF SHIPMENTS--1967, 1971-1974
ACCORDING TO 1972 CENSUS DEFINITION OF THIS INDUSTRY
(Dollars in Millions)

Line	Item	1967	1971	1972	1973	1974[6] Low	1974[6] High
1.	Value of all products and services sold by SIC 2821 industry[1]	$2,619.5	$3,318.1	$4,497.0	$5,303.8	$6,100	$6,897
2.	Value of SIC 2821 products shipped by SIC 2821 industry[2]	2,093.1	2,878.2	3,574.0	4,215.2	4,848	5,482
3.	Value of SIC 2821 products shipped by all industries[3]	2,784.9	3,635.3	4,514.1	5,324.0	6,123	6,922
4.	Ratio of SIC 2821 products shipped by SIC 2821 industry to total shipments of SIC 2821 products by all industries (coverage ratio)[4]	0.75	0.79	0.79	0.79	0.79	0.79
5.	Value of major SIC 2821 product categories shipped by SIC 2821 industry:[5, 7]						
	Total Thermoplastics	$1,510.4	$2,166.6	$2,870.1	$3,394.4	$3,904	$4,481
	Low-density polyethylene	264.7	430.5	500.1	585.3	673	768
	High-density polyethylene	154.0	185.6	226.8	271.2	312	343
	Polypropylene	88.0	165.7	216.0	296.3	341	416
	PVC	268.6	362.9	446.4	509.2	585	653
	Polystyrene	176.5	328.3	400.5	447.4	515	602
	Other	558.6	693.6	1,080.3	1,285.0	1,478	1,699
	Total Thermosets	582.7	711.6	703.9	820.8	944	1,001

Footnotes:

(1) Figures for 1967, 1971 and 1972 obtained from, respectively, Sources (a), (b), and (c) (data for 1967 and 1971 revised according to 1972 definition of SIC 2821). Figures for 1973 and 1974 obtained from values in line 2 using same ratio as for 1972.

(2) Figures for 1967 and 1972 obtained from, respectively, Sources (a) revised according to 1972 definition of SIC 2821) and (c). Figure for 1971 obtained from value in line 3 using ratio given in line 4. Figures for 1973 and 1974 represent sums of values for individual product categories.

(3) Figures for 1967, 1971, and 1972 obtained from, respectively, Sources (a), (d), and (c). Figures for 1973 and 1974 obtained from values in line 2 using ratio given in line 4.

(4) Ratios for 1967 and 1972 are those which were established in, respectively, Sources (a) and (c). Ratios for 1971-1974 have been assumed to be constant.

(5) Figures for 1967 obtained from Source (a). Total thermoplastics and thermoset figures for 1971 and 1972 obtained from, respectively, Sources (b) and (c). Figures for individual product categories for 1971 and 1972 obtained from volume of shipment in, respectively, Sources (e) and (f) using prices given in Source (g). Figures for 1973 obtained from volume of shipment data in Source (f) and reflect a 4% increase in price over 1972 (Source (h)). Total thermoplastics and thermoset figures include allocations of synthetic resins for protective coatings and SIC 2821 products, n.s.k. for companies with 10 employees or more and have been adjusted for multiplying by the ratios given in line 4.

(6) Figures for 1974 built up from individual product category figures which are estimated to range from a minimum of zero growth to a maximum of a continuation of the historical growth rate from 1967 to 1973. All figures reflect a price increase of 15%.

(7) There is some disagreement regarding the classification of coumarone indene and petroleum polymer resins. For the purposes of this study, they have been included among the thermoplastics.

Sources:

(a) "Industry Statistics," 1967 Census of Manufactures, U.S. Department of Commerce, Volume II, Part 2 Major Groups 25-33, 1971 pp. 28B-1-25.

(b) "General Statistics for Industry Groups and Industries," Annual Survey of Manufactures-1971, U.S. Department of Commerce, Publication M71 (AS)-1, April 1973.

(c) "Plastics Material and Resins, SIC 2821," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC 72 (P) -28B-1, December 1973.

(d) "Value of Product Shipments," Annual Survey of Manufactures - 1971, U.S. Department of Commerce, Publication M71(AS)-2, October 1973.

(e) "Plastiscope 3," Modern Plastics, Volume 50, No. 7, July 1973, p. 100.

(f) "Production & Sales - 1973 Estimates," SPI Flashtics, Society of the Plastic Industry, Volume 3, No. 2, January 1974.

(g) "U.S. Production and Sales of Plastics and Resins Materials - 1972 (Preliminary)," Synthetic Organic Chemicals, U.S. Tariff Commission, February 1974.

(h) "The Modern Plastics Barometer," Modern Plastics, Volume 51, No. 1, January 1974, p. 5.

Exhibit IV-5 FEO:USDC

SIC 2821 - PRODUCTION VOLUME--1967, 1971-1974
ACCORDING TO 1972 CENSUS DEFINITION OF THIS INDUSTRY
(Pounds in Millions)

Line	Item	1967 (6)	1971	1972	1973	1974 (7) Low	1974 (7) High
1.	Total production by SIC 2821 industry (1)	12,974	19,232	24,661	27,185	27,185	30,861
2.	Total production of SIC 2821 products by SIC 2821 industry (2)	10,367	16,683	19,600	21,605	21,605	24,527
3.	Total production of SIC 2821 products by all industries (3)	13,793	21,071	24,755	27,288	27,288	30,979
4.	Ratio of production of SIC 2821 products by SIC 2821 industry to total production of SIC 2821 products by all industries (4)	0.75	0.79	0.79	0.79	0.79	0.79
5.	Production of major SIC 2821 product categories by SIC industry: (5, 8)						
	Total Thermoplastics	7,938.7	13,820	16,000	17,661	17,661	20,248
	Low-density polyethylene	2,041.7	3,556.2	4,175.6	4,588.9	4,589	5,254
	High-density polyethylene	813.4	1,496.3	1,840.8	2,071.2	2,071	2,423
	Polypropylene	497.8	1,060.5	1,366.5	1,701.4	1,701	2,083
	PVC	1,610.3	2,721.5	3,373.0	3,611.9	3,612	4,136
	Polystyrene	1,518.2	2,222.0	2,485.3	2,585.8	2,586	2,832
	Other	1,457.3	2,763.5	2,759.8	3,101.7	3,102	3,520
	Total Thermosets	2,428.2	2,862.3	3,600.1	3,944.4	3,944	4,279

Footnotes:

(1) Figures stated in "equivalent" pounds of SIC 2821 products calculated from figures in line 2 by applying the ratio of the total value of all products and services sold by SIC 2821 industry to the value of SIC 2821 products shipped by the industry (see Exhibit IV-4).

(2) Figures calculated from quantities in line 3 multiplied by ratio given in line 4.

(3) Figures for 1967 obtained from Source (a), for 1971 from Source (b), and for 1972 and 1973 from Source (c). Data from Source(d) shows that Tariff Commission and SPI figures are comparable within approximately ± 1%.

(4) Production ratios assumed to be same as ratios of the value of shipments given in Exhibit IV-4.

(5) Figures for 1967, 1971, 1972 and 1973 obtained from Sources given in Footnote (3) adjusted by multiplying by the ratio given in line 4.

(6) Figures are from Source (a) and include an allocation of synthetic resins for protective coatings and SIC 2821 products n.s.k. for companies with 10 employees or more.

(7) Range of estimate is from a minimum of zero growth to a maximum of a continuation of the historical growth rate from 1967 to 1973.

(8) There is some disagreement regarding the classification of coumarone indene and petroleum polymer resins. For the purposes of this study, they have been included among the thermoplastics.

Sources:

(a) "Plastics and Resin Materials: U.S. Production and Sales, 1967," Synthetic Organic Chemicals, U.S. Tariff Commission, TC Publication 295, 1969, pp. 36-40.

(b) "Plastics and Resin Materials: U.S. Production and Sales, 1971," Synthetic Organic Chemicals, U.S. Tariff Commission, TC Publication 614, 1973, pp. 133-6.

(c) "Production & Sales - 1973 Estimates," SPI Flashtics, Society of the Plastics Industry, Volume 3, No. 2, January 1974, p. 2.

(d) "Plasticscope 3," Modern Plastics, Volume 50, No. 7, July 1973, p. 100.

EXHIBIT IV-6
FEO: USDC
SIC 2821 - ENERGY FACTORS FOR MAJOR PROCESSES--PRESENT STATE OF THE ART[1]

(Per Million Pounds Produced)

	Monomer (Million Lbs.)	Electricity[2] (Million KWH)	Fuel (Billion BTUs)	BTUs (Billions)	KWH Equivalents (Millions)
Low Density Polyethylene[3]	1.047	0.58	5.0	11.3	3.3
High Density Polyethylene[4]	1.040	0.4	2.3	6.5	1.9
Polystyrene[3]	1.05[4]	0.17	1.5	3.4	1.0
Polypropylene[5]	1.040	0.3	1.7	5.1	1.5
Polyvinyl Chloride[6]	1.030	0.84	2.7	11.6	3.4

(1) Energy factors are representative values, but substantial variations exist from plant to plant as a function of age, size, design and operating conditions.

(2) Assumed to be purchased electricity for purposes of Required Tables 2, 3 and 4.

(3) Source: Society of Plastics Industry.

(4) Snell estimates based on industry interviews and the literature. Regarding HDPE see discussion on page IV-15.

(5) Snell estimates based on "The Plastics Industry In The Year 2000", Stanford Research Institute, April 1973.

(6) Snell estimates based on Conference Board data.

EXHIBIT IV-7
FEO:USDC
SIC 2821 - ENERGY FACTORS--1967, 1971 AND 1973

(Per Million Pounds Produced)

Line		Units	1967 (2)	1971 (2)	1973 (3)
1.	Production (1)	Millions equivalent pounds	17,206	25,498	
2.	BTU equivalents of fuel	Billion BTUs	5.56	4.75	4.36
3.	Coal	Short ton	83.3	55.7	41.9
4.	Fuel oil				
5.	Distillate	Barrels	98.7	63.1	45.3
6.	Residual	Barrels	85.4	128.5	150.1
7.	Natural gas	Million cft	2.2	2.5	2.0
8.	Other	Dollars	163	(Z)	(Z)
9.	Not specified	Dollars	180	(Z)	(Z)
10.	Electricity				
11.	Purchased (4)	Million KWHs	0.25	0.32	0.36
12.	Purchased (4)	Billion BTUs	2.65	3.39	3.76
13.	Generated (4)	Million KWHs	0.03	0.03	
14.	BTU equivalents of fuels and purchased electricity	Billion BTUs	8.21	8.14	8.12

(1) Not reflecting the 1972 census definition of the industry since the census fuel surveys for 1967 and 1971 do not. Figures obtained by applying the ratio of the 1971 change in the U.S. total value of shipments due to the redefinition to the production figures of Exhibit IV-5, Line 1. The ratio is $4.4 billion to $3.3 billion.

(2) Figures for 1967 and 1971 on Lines 3, 4, 5, 6, and 9 are the quotient of census data from "Fuels and Electric Energy Consumed," MC67(S)74 and MC72(SR)-6 respectively divided by the figures on Line 1.

(3) Lines noted in (2) are extrapolated from 1967 and 1971 data.

(4) Estimates for 1971 and 1973 based on changes in product mix, shown in Exhibit IV-8, for the major resins.

EXHIBIT IV-8
FEO: USDC
SIC 2821 - PRODUCT MIX

Line	Item	1967	1971	1973
		Year		
1.	Total production by SIC 2821 industry, million pounds	13,461	19,323	27,185
		Percent of Total		
	Low density polyethylene	13.7	18.5	16.9
	High density polyethylene	8.1	7.8	7.6
	Polypropylene	3.4	5.5	6.3
	PVC	14.7	14.1	13.3
	Polystyrene	9.0	11.5	9.5
2.	Other	51.1	42.6	46.4
	Total	100%	100%	100%

Source: Exhibit IV-5.

EXHIBIT IV-9 a
FEO:USDC
SIC 2821 - EMPLOYMENT AND SHIPMENTS
DATA--1967 CENSUS DEFINITION

Shipments, Employment, and Fuels and Energy Consumed by Geographic Unit, 1971 and 1973

SIC 2821 Industry Plastics Materials and Resins

(Not reflecting 1972 Census redefinition of the industry)

Line Number	Geographic Unit	Value of Shipments ($000) 1971 (1)	1973	% Change	Employment 1971 (2)	1973 (3)	% Change	Fuels and Energy (Mil. BTU's) 1971	1973	% Change
1	United States	4,400			75,354	79,400	5.4%			
2	NORTH EAST	(NA)			20,892	20,800	(0.4)			
3	New England	400								
4	Maine									
5	N.H.	(NA)								
6	Vermont	(NA)								
7	Mass.	280			6,440	6,690	3.9			
8	R.I.				815	900	10.4			
9	Conn.	(NA)								
10	Middle Atlantic	1,000								
11	N.Y.	160			4,509	4,060	(10.0)			
12	N.J.	400			9,128	10,020	9.8			
13	Penn.	500			(NA)	(NA)				
14	NORTH CENTRAL	1,160			(NA)					
15	E. North Central	990								
16	Ohio	360			4,734	5,170	9.2			
17	Ind.	(NA)								
18	Ill.	170			(NA)	(NA)				
19	Mich.	170			3,860	4,310	11.7			
20	Wisc.				1,361	(NA)	(X)			
21	W. North Central	170			(NA)	(NA)	(X)			
22	Minn.				553	670	24.8			
23	Iowa	(NA)								
24	Mis.	(NA)								
25	N.D.									
26	S.D.									
27	Neb.	(NA)								
28	Kans.									

(1) Snell estimates based on data from Annual Survey of Manufacturers, M71 (AS)-6.1 through 6.9 and not reflecting the 1972 census redefinition of SIC 2821, discussed in Exhibit IV-4.
(2) Source: "Country Business Patterns," (CBP) 1971. The Bureau of Labor Statistics (BLS) reported 88,700 employees for 1971. Geographic distribution data in CBP more complete, hence this source is used to estimate percent change.

Line Number	Geographic Unit	Value of Shipments ($000)			Employment			Fuels and Energy (Mil. BTU's)		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
29	SOUTH	1,540								
30	S. Atlantic	670			1,677	1,760	4.9%			
31	Del.									
32	Md.	(NA)								
33	D.C.									
34	Va.	(NA)								
35	W. Va.	(NA)								
36	N.C.	(NA)								
37	S.C.	(NA)								
38	Ga.	(NA)								
39	Fla.	(NA)								
40	S. Central	870			1,426	1,700	19.2			
41	Ky.									
42	Tenn.	150								
43	Ala.	(NA)								
44	Miss.				130	(NA)				
45	Ark.				1,922	1,770	(7.9)			
46	La.					296	(NA)			
47	Okla.	(NA)			3,964	4,330	6.7			
48	Texas	360								
49	WEST	(NA)								
50	Mountain	(Z)								
51	Mont.									
52	Idaho									
53	Wyo.									
54	Colo.									
55	N.M.									
56	Ariz.									
57	Utah									
58	Nev.									

Line Number	Geographic Unit	Value of Shipments ($000)			Employment			Fuels and Energy (Mil. BTU's)		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
59	Pacific	300								
60	Wash.	(NA)								
61	Ore.	(NA)								
62	Cal.	(NA)			3,776	4,070	7.8%			
63	Alas.									
64	Haw.	(Z)								

(3) CBP 1972 U.S. total employment was 75,613 and the change from 1971 to 1972 was 0.34%. The 1973 U.S. total employment was derived from applying the 5.4% change in the BLS data (93,500 employees in 1973 from 88,700 in 1971) to the 1971 CBP figures. The state and regional 1973 employment was estimated by applying the 5.4% increase in employment from 1972 to 1973 uniformly.

SECTION V

SIC 2822, SYNTHETIC RUBBER

Exhibit V-1 at the end of this section, presents a detailed industry definition. In 1971 value added by manufacture was $477 million according to the Annual Survey of Manufactures, while value of shipments was $1,043 million and total gross book value of depreciable assets was $740 million. The same source reports energy consumption of 17.3 billion KWH equivalents. County Business Patterns, 1971, reports that about 50 establishments were classified in SIC 2822.

The most important findings follow regarding the economic impact of the petroleum based materials shortages during 1973 and the first quarter of 1974:

- Fuel shortages, although of concern, have not had any appreciable effect on industry operations.
- Materials shortages, especially styrene, have resulted in cutbacks in the output of rubber and deferrment of some expansion plans.
- Employment in the industry has decreased and continuation of this trend was projected for 1974.
- No major opportunities appear to exist for substitutions and/or conservation of petroleum based materials.
- There are wide differences in the energy efficiency of major processes, with SBR more efficient than the other rubbers.

Exhibit V-2, following Exhibit V-1, features the Required Tables. These tables and supporting exhibits further define the industry's structure both in economic and energy terms.

All exhibits appear sequentially at the end of this section. Whenever electricity KWHs are expressed as BTUs, conversion is based on the nominal fuel requirements to generate the electricity.

1. MAJOR USES OF FUELS, ENERGY AND PETROLEUM PRODUCTS

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

1.1 Task I, Major Processes

Polymerization of unsaturated monomers is the basic method of manufacture in the synthetic rubber industry, generally using continuous equipment for the large volume types of rubber, although various small volume specialty items may be made in batch equipment. The use of significant amounts of process steam is characteristic of the industry.

SBR, styrene-butadiene rubber, is the largest production item and the primary material for automotive tires.

It is generally produced via emulsion polymerization, although about 10% is from solution polymerization. Besides the styrene and butadiene which are used in the manufacture of SBR, other important monomers include isobutylene, ethylene, propylene, acrylonitrile, isoprene and chloroprene, and other chemical materials used to a lesser extent in specialty rubbers. All of these monomers are of direct petro-chemical origin, examples of which follow:

Styrene

From ethyl benzene obtained from alkylization of benzene with ethylene, or by super fractionation of aromatic refining streams. Styrene has to compete for its benzene supplies with other large volume chemical intermediates.

Butadiene

From catalytic dehydrogenation of n-butane or butenes derived from high temperature petroleum streams, or by direct recovery from co-product streams.

Ethylene and Propylene

Are basic light fractions from cracking and/or natural gas liquids.

Acrylonitrile

Is made by reacting propylene and ammonia in the Sohio process.

Yields from all of these monomers to the corresponding synthetic rubbers are very high and probably not susceptible to much further improvement.

The polymerization reaction also consumes a variety of additives such as catalysts, surfactants and coagulants, but in small quantities relative to the tonnage of rubber produced.

The rubber requires compounding with relatively large amounts of carbon black and extender oils of petroleum origin, antioxidants, vulcanizing agents, etc. These may be added either by the rubber maker, or the final maker of rubber products. Carbon black, obtained by incomplete combustions of heavy oils, high aromatic extender oils, and naphthenic or solvent refined paraffinic processing oils, accounts for the major usage of petroleum-based materials in the compounding and manufacturing end of the rubber industry.

The major processes of the industry include the manufacture of SBR, butyl rubber, polybutadiene, and polyisoprene. These accounted for approximately 71% of the equivalent production of the industry in 1973 as shown in Exhibit V-2-1.

1.2 Task II, Industry Output

Exhibit V-3 summarizes estimates of the value of overall industry shipments as well as value of shipments by major product for 1967 and 1971-1974. In 1973, the value of all products and services sold by SIC 2822 industry was a little greater than $1,100 million.

Exhibit V-4 summarizes production volume in the same terms. In 1973, total production of SIC 2822 products by SIC 2822 industry was about 4,200 million pounds. Total production by SIC 2822 industry was about 4,800 million equivalent pounds.

Based on the data in Exhibits V-3 and V-4, Exhibit V-2-1 provides the information of Required Table 1.

1.3 Task III, Energy Related Profile of Major Processes

Energy factors have been estimated for the manufacturing processes associated with the major products listed under Task 1.1 above. Exhibit V-5 summarizes these data.

Required Tables 2, 3, and 4 are presented respectively for SBR, butyl rubber, polybutadiene elastomers and polyisoprene elastomers in Exhibits V-2-2, V-2-3, and V-2-4. Series "a" through "d" correspond to each type of rubber in these tables.

The major sub-processes discussed above accounted for 70% of the equivalent pounds of synthetic rubber produced in 1971 as shown on Line 1 of Exhibit V-4. They accounted for 40% BTUs for the industry reported by census and for 47% of the electrical energy and 38% of the fuel BTUs.

1.4 Task IV, Shifts in the Energy Related Profile of the Industry 1971 to 1973

Exhibit V-6 summarizes industry level energy factors based on census data and Snell estimates. The 1971 census does not report electricity usage. Thus, electricity purchased in 1971 has been estimated based upon 1967 data. Manufacture of the four major synthetic rubber products accounts for about half of the electricity used. For 1973 fuel items, extrapolation of the census trend using 1967 and 1971 figures were used where possible. Based on these data, Exhibit V-2-5 was prepared, presenting Required Table 5.

The following are observations from Exhibit V-6 regarding extrapolated fuel shifts from 1971 to 1973 in terms of fuel requirements per equivalent unit of production:

- A shift away from the use of coal (19% reduction per equivalent pound of rubber produced).

- A shift toward the use of more natural gas (9% increase per pound).

- A 5% increase in fuel plus purchased electricity requirements per pound. Such a result could be expected from the shift in product mix away from SBR and toward the more energy intensive production of other types of synthetic rubber as indicated by the change in product mix shown in Exhibit V-7.

The following are observations from Exhibit V-2-5 regarding shifts in the energy profile of SIC 2822 from 1971 to 1973:

- The total BTU requirements of the industry increased about 14%.
  - This increase was due primarily to the nearly 18% increase in the use of natural gas.
  - The consumption of "fuels, n.e.c." also increased at a rate above the industry level increase, but the absolute quantity consumed was insignificant compared to the total.
- The following energy items changed at a rate near or below the industry level increase
  - distillates: 11%
  - residuals: 13%
- The consumption of coal decreased over 9%.

1.5 Task V, Projected 1974 Energy Related Profile of the Industry

Exhibit V-2-5 also presents the projected energy profile of SIC 2822 for 1974. The profile was developed assuming the same energy factor for 1974 as for 1973, shown in Exhibit V-6, because product mix changes between the two years are not expected to be substantial. The factor was applied to the average expected production of 1974, i.e., the average of the "low" and "high" figures given in Line 1 of Exhibit V-4. Use of the 1973 energy factor assumes no significant increase in the energy required per unit of production from 1973 to 1974, and a total energy requirement of 91,600 billion BTUs is projected for 1974.

2. GEOGRAPHIC PATTERN OF USE

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

2.1 Task I, Geographic Pattern of the Industry's Energy Related Profile - 1971 to 1973

The synthetic rubber industry is very heavily concentrated in the Gulf Coast area with a smaller grouping in the Ohio/Kentucky area and minor installations in Connecticut and Tennessee. The Required Tables in Exhibits V-2-6, 7, and 8 define the geographic distribution of this industry's energy related profile. This distribution is based upon the SIC 2822 national consumption of fuels and energy shown in Exhibit V-2-5 distributed according to the synthetic rubber production capacity.

2.2 Task II, Geographic Pattern of Employment and Shipments - 1971 to 1973

Employment and origins of shipments are concentrated in the Gulf Coast area with a smaller, but sizeable grouping in the Ohio/Kentucky area. The distribution of synthetic rubber production capacity from a report by the International Institute of Synthetic Rubber Producers, Inc. was used as the basis for distributing both employment and value of shipments among all producing states. Exhibit V-8 illustrates this approach for industry employment.

2.3 Task III, Shifts in Patterns

Between 1971 and 1973, SIC 2822 value of shipments and fuels and energy consumption increased while industry employment decreased. At the industry level, these shifts were as follows:

- There was about a 7% increase in the value of products and services sold by SIC 2822 industry.
- There was about an 8% decrease in employment.
- There was about a 14% increase in the amount of fuel and energy consumed.

3. FUEL AND ENERGY SUPPLY SITUATION

The principal outputs of this subsection are Required Tables and analyses of findings. The findings were developed through the assistance of the International Institute of Synthetic Rubber Producers, Inc. It should be noted that the data has been derived from industry interviews and a small representation of synthetic rubber producers and is therefore only illustrative in nature.

3.1 Task I, Normal Stocks of Materials

Exhibit V-2-9 presents data on the normal stocks of materials for 1972 and 1973. The flow of fuel and energy materials for the synthetic rubber industry range from direct pipeline supply in some instances to stocks sufficient for 6-months production in other cases. On the average, one to three weeks supply of materials can be taken as the norm.

3.2 Task II, Shifts in Stocks

Exhibit V-2-9 also gives an indication of the stocks of materials on hand as of 12-31-73 and 3-31-74. As can be seen, although there are certain instances where stocks of materials are below the levels of previous years, in most cases the levels have been sufficient for production requirements.

Although no specific information is available as a function of establishment size, interviews indicate that synthetic rubber plants which are subsidiaries of oil companies have not been affected to the extent of independent producers in their ability to obtain materials supplies.

3.3 Task III, Captive Use

A certain amount of butadiene, isoprene and other raw materials are produced by some of the firms which manufacture synthetic rubber. One respondent produces middle distillates captively.

Natural gas and electricity are the principal items and are not produced captively in this industry. One manufacturer reported the use of in-house by-product gas as an energy source.

Required Table 10 is not presented.

3.4 Task IV, Sources of Supply

Exhibit V-2-11 presents the sources of supply of fuels and energy by type. Most of these production necessities are purchased from outside suppliers.

In only one case did a synthetic rubber manufacturer report the purchase of a raw material from an importer.

3.5 Task V, Proportion by Type of Supplier

Other manufacturers and utilities appear to be the most important suppliers of fuel and energy materials to the synthetic rubber industry. Required Table 11 is not provided due to the qualitative nature of data.

3.6 Task VI, Seasonality of Use

Exhibit V-2-12 shows that nearly all fuel and energy materials supplied to the synthetic rubber industry were used at a steady rate throughout 1973. One producer showed some seasonality in the use of ethylene and propylene with very little being used in the second quarter. Another producer indicated essentially all of the 1973 consumption of distillates in the first quarter of the year.

4. SUBSTITUTABILITY AND CONSERVATION OF MAJOR FUELS AND PETROLEUM PRODUCTS

The findings under this section were developed through the assistance of the International Institute of Synthetic Rubber Producers, Inc. and through interviews with executives of seven major producing companies, as well as review of secondary and in-house information.

4.1 Task I, Major Processes

There is virtually no opportunity for substitution or replacement of monomeric materials in any of the major types of synthetic rubbers, although considerable developmental effort has been directed to achieving minor reductions in content of critically short styrene, whenever the nature of the end use permits.

With regard to fuels, five out of nine respondents use natural gas exclusively. One buys steam (coal-fired) from a nearby industrial plant. Another has been able to recommission coal burning equipment in older plants and is now able to switch from gas to coal or oil as circumstances dictate in most operations.

4.2 Task II, Quantifications of the Major Substitutability and Conservation Opportunities

One respondent is making an economic analysis of the replacement of gas turbine equipment with high pressure steam at one location. The project would involve a $20 to $30 million investment and would take three to four years to complete. There would be a relatively small saving in total heat consumed but mainly a replacement of natural gas by coal. Another is beginning to install standby oil burning equipment in case supplies of natural gas are curtailed.

Two other respondents have major scale fuel conservation projects not directly in SIC 2822 operations but in closely associated ones. The first is striving to develop a major process improvement in a captive butadiene plant. If successful, it would reduce natural gas consumption by 50% or nearly 50 million cubic feet per day. The second has just installed waste heat boilers to burn the off gases from a carbon black plant and has a second installation on the drawing board.

In recent years, the product mix among synthetic rubbers has been away from SBR, the least energy-intensive of all the major synthetic rubbers. If this trend continues, as it is expected to with the increasing importance of the radial tire for which polyisoprene is preferred, energy consumption per pound of tire will most likely increase.

4.3 Task III, Principal Constraints

The constraints mentioned were the usual ones of engineering on a crash basis:

- providing change in technology
- justifying the capital expenditure and raising the money
- long delivery time for large tanks, pumps, piping and other equipment.

4.4 Task IV, Plant Level Operating Characteristics

If fuel were curtailed but remained steadily available at some reduced level, most respondents stated that loss of output would be more or less proportional in about the upper 25% of a given plant's capacity range, but would fall off much more sharply thereafter. Many plants operate with more than one line. Thus, a reduction in fuel supplies could be translated into the shutdown of one or more complete lines while allowing full utilization of remaining capacity.

However, any sudden stoppage of fuel would shut down the entire operation. Since cleanup and preparation times are long, the loss in output would be many times the actual boiler outage.

With respect to a reduction in monomer supplies, many operations can be slowed down process-wise to some degree, but curtailment of monomers beyond that means shutting down whole lines and/or stopping production of the affected rubber types.

Economically, all of the new and larger plants are highly capital intensive with breakeven points reported to be above 70% of capacity. For SBR and butyl rubber, breakeven is stated to be above 80% of capacity.

4.5 Task V, Capital Stock (1973)

The 1973 gross book value of fixed assets is about $800 million. This estimate is based on the following:

- The 1971 Annual Survey of Manufactures indicates that the gross book value of fixed assets was $740 million in 1971.
- According to the same source, capital expenditures in 1971 were $34 million.
- Only one new plant was due for start-up in 1973, although there is some plant expansion work in progress.
- Two synthetic rubber plants have been at least partially shut down in the last one to one and one-half years. At least one of these, however, was of WW II vintage.

The present estimated capital cost of a synthetic rubber facility is about $500 per long-ton of production capacity. As there is presently about 2,930 long-tons of capacity in the United States, the replacement cost of present capacity is about $1.5 billion.

4.6 Task VI, Planned Capital Investment (1974)

There appear to be no major near-term expenditures planned for completion in 1974. However, as mentioned above, one respondent has started to install a waste heat boiler to utilize off gases from the second of his two carbon black plants. This will be a multi-million dollar investment planned for completion in early 1975.

Another (major) respondent has commenced work on an approximately 50% expansion of facilities for butyl and chlorobutyl rubber, plus a 10% expansion of EPM capacity with completion more than two years away. Considering such expansion and facility improvement plans, capital expenditures in 1974 are estimated at $25-30 million.

4.7 Task VII, Changes to Investment Plans

The investment plans referred to above and others being contemplated by the industry will be most strongly influenced by:

- the outlook for monomer supplies
- the outlook for tire sales as dependent upon gasoline availability, miles driven, the sizes of automobiles coming into use, etc.

- the outlook for fabricated rubber products

Because of present uncertainties, the expansion plans of a number of synthetic rubber producers have been held in abeyance until such time that the outlook becomes clearer.

5. INTRA-INDUSTRY EFFICIENCY

The findings in this subsection have been developed through interviews with industry executives and analysis of in-house data.

5.1 Task I, Energy Efficiency

The energy efficiency of SIC 2822 industry has shown a decreasing trend in recent years (see Exhibit V-6). One of the major reasons for this is the increasing production percentages of the more energy-intensive rubbers in the product mix (see Exhibit V-7). The Conference Board confirms this trend as indicated in the table below showing the expected trend in fuels and fuel equivalents of electricity consumed per unit of output.

Year	BTUs per 1967 $ of Shipments
1962	58,600
1967	77,200
1971	83,500
1975	86,900

Source: The Conference Board

BTUs per 1967 $ of shipment consider the BTU contents of fuels consumed and that of fuel required to generate the electricity used. In the early 1960s the product mix of synthetic rubbers changed somewhat, with a decrease in the share of SBR in favor of newly commercialized stereo elastomers, polybutadiene and polyisoprene. These are solutions polymerized with greater steam requirements than SBR which is principally emulsion polymerized. The growth in the energy factors is expected to continue as shown above due to, for example:

- growth of polyisoprene, possible with the increasing market share of tires, especially if natural rubber supplies become spotty or too costly

- shift in the SBR: polybutadiene mix in passenger car tires from 65:35 toward 50:50

Exhibit V-5 presents figures on the amounts of energy required to produce four major synthetic rubber types. Within this group the required energy per unit of output varies five-fold. Within any one product group, it is the usual case that a plant will have a number of production lines. For SBR, these lines tend to run over 30,000 tons per year but in similar sizes, thus giving little room for a variation in energy consumption as a function of size, although this can be substantial regarding age and variations in design and operations.

5.2 Task II, Major Factors Affecting Efficiency

The synthetic rubber industry has already begun to look for means to conserve energy. Outside of possible technological improvements, successful ventures to date include installation of a waste heat boiler to burn off-gases and the use of waste tar instead of fuel oil to provide steam.

6. PRINCIPAL CONSTRAINTS ON INDUSTRY OPERATIONS

The findings presented in this section have been obtained through the assistance of industry spokesmen and through the analysis of secondary sources and in-house information.

6.1 Task I, Important Constraints

Broadly speaking, allocation of petrochemical feedstocks and petrochemicals did not reduce synthetic rubber output much below market needs during 1973 and the first quarter of 1974. 65% of the industry output goes into tires, the demand for which is an important constraint on the synthetic rubber industry.

Monomer shortages and uncertain, but large expected price increases have forced cutbacks in output of rubber and deferrment of expansion plans. A shortage of styrene, which has been the direct result of an extreme shortage of benzene from which it is made, has been a particular problem. This situation has been aggravated, it is reported, by the fact that styrene producers have been diverting this monomer into their own captive production of polystyrene group plastics. It is also reported that export sales of styrene and benzene have contributed to the shortage. Butadiene is also reported to have been in short supply.

Recent FEO action may result in a significant increase in the availability of benzene based materials, according to De Witt and Company:

- The new February 25 regulations permit aromatics producers to increase benzene prices by 33.7 cents per gallon and toluene prices by 28.8 cents per gallon. The reduction required in the pass-through of feedstock cost to prices of other covered products has been dropped to 20 cents per gallon benzene and toluene, multiplied by May, 1973 sales of benzene and toluene rather than current production.

- Thus, the producer gets the full benefit of the price increase permitted, which should make benzene and toluene recovery more attractive than leaving them in gasoline, where there has been no major change in price controls.

- While these new regulations will increase benzene producers' profits and stimulate new production, they should not affect the trends in pricing already established by the January 31 regulations.

- The new regulations do not restrict benzene exports in terms of price or allocation.

  - exports of most other petroleum products have been cut back by quotas imposed by the Department of Commerce, rather than by any action of the FEO

  - legislation has been introduced to restrict exports of those petrochemicals still under price controls, but no action in the near future is likely.

Despite the fact that this relaxation in controls will ease the benzene supply situation, it is important to realize that benzene production capacity is limited. In the near-term, this capacity restriction will impose a new limit on the supply of benzene.

6.2 Task II, Most Serious Constraint

The most serious constraint is probably raw materials shortages. Four respondents stated that the styrene shortage is by far the most serious constraint on their output. However, there are predictions of increased supply of benzene related materials and increased oil imports which, if they come true, could ease the situation (within the constraints of capacity) during the later half of 1974. If this does occur to an appreciable extent, demand in the tire industry will be indicative of what future constraints may be.

6.3 Task III, Shortfall in Supply and Price Increases

All respondents report runaway price increases in all raw materials, but are generally optimistic about being able to pass such increases through to their customers.

Rubber is used in a wide variety of products, many of which are reported to be produced by small companies. Any shortages of synthetic rubber will probably have a more pronounced effect on these smaller business because of their lack of finanical strength compared to larger firms.

6.4 Task IV, Outputs Critical to Subsequent Production

The outputs of the synthetic rubber industry go into:

- new tire production (about 65%)
- tire retreading
- molded rubber goods
- footwear
- adhesives
- others

in approximately decreasing order. All of these industries are significantly more labor intensive than the highly capital intensive production of synthetic rubber. None of the respondents considered themselves in a position to estimate ratios between relative man-hour impacts, but all agreed that any curtailment of rubber supplies would cause a disproportionately large amount of unemployment in any of the consuming industries.

EXHIBIT V-1
FEO: USDC
DEFINITION OF SIC 2822

SIC 2822 SYNTHETIC RUBBER (VULCANIZABLE ELASTOMERS) (1)

Establishments primarily engaged in manufacturing synthetic rubber by polymerization or copolymerization. An elastomer for the purpose of this classification is a rubber-like material capable of vulcanization, such as copolymers of butadiene and styrene, or butadiene and acrylonitrile, polybutadienes, chloroprene rubbers, and isobutylene-isoprene copolymers. Butadiene copolymers containing less than 50% butadiene are classified in Industry 2821. Natural chlorinated rubbers and cyclized rubbers are considered as semifinished products and are classified in Industry 3069.

Acrylate type rubbers
Acrylate-butadiene rubbers
Acrylic rubbers
Adiprene
Butadiene-acrylonitrile copolymers (over 50% butadiene)
Butadiene rubbers
Butadiene-styrene copolymers (over 50% butadiene)
Butyl rubber
Chlorinated rubbers, synthetic
Chloroprene type rubbers
Chlorosulfonated polyethylenes
Cyclo rubbers, synthetic
EPDM polymers
Elastomers, vulcanizable (synthetic rubber)
Epichlorohydrin elastomers
Estane
Ethylene-propylene rubbers
Fluoro rubbers
Fluorocarbon derivative rubbers
Hypalon
Isobutylene-isoprene rubbers
Isocyanate type rubber
Isoprene rubbers, synthetic
Neoprene
Nitrile-butadiene rubbers
Nitrile-chloroprene rubbers
Nitrile type rubber
N-type rubber
Polybutadienes
Polyethylenes, chlorosulfonated
Polyisobutylene-isoprene elastomers
Polyisobutylene (synthetic rubber)
Polymethylene rubbers
Polysulfides
Pyridine-butadiene copolymers
Pyridine-butadiene rubbers
Rubber synthetic
Silicone rubbers
S-type rubber
Stereo regular elastomers
Styrene-butadiene rubbers (50% or less styrene content)
Styrene-chloroprene rubbers
Styrene-isoprene rubbers
Thiol rubbers
Urethane rubbers
Vulcanized oils

Source: 1972 Standard Industrial Classification Manual

(1) The 1972 SIC definition is the same as that used in the 1967 census.

EXHIBIT V-2-1
FEO:USDC
REQUIRED TABLE 1

Proportion of Industry Output Accounted for by Each Major Process, 1973

SIC 2822 Industry Synthetic Rubber (Vulcanizable Elastomers)

Process and Major Products	Percent of 1973 Shipments Value	Percent of 1973 Production Volume 1/
S-type rubber	34.9%	51.0%
Butyl rubber	5.8	5.3
N-type rubber	5.3	2.8
Stereo polybutadiene elastomers	7.8	11.2
Stereo polyisoprene elastomers	4.1	3.9
Ethylene propylene elastomers	4.8	4.0
Other elastomers	24.6	9.0
Secondary products and miscellaneous receipts	12.7	12.9
Total Industry (Percent)	100.0	100.0
(Actual)	$1,113,400,000	4,808,400,000

1/ Production volume expressed in pounds.

Source: Exhibits V-4 and V-5, Line 1, dealing with the total output of plants classified in SIC 2822.

EXHIBIT V-2-2a
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume.

SIC 2822 Industry Synthetic Rubber

Process S-Type Rubber

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion cu. ft.	9.3			9.3	9.8			9.8
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	360			360	380			380
12	GRAND TOTAL									

EXHIBIT V-2-3a
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in BTU s.

SIC 2822 Industry Synthetic Rubber

Process S-Type Rubber

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion BTU s	9,600			9,600	10,100			10,100
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTU s	3,800			3,800	4,000			4,000
12	GRAND TOTAL	billion BTU s				13,400				14,100

EXHIBIT V-2-4a
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalent.

SIC 2822 Industry Synthetic Rubber

Process S-Type Rubber

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	million KWH	2,800			2,800	3,000			3,000
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased) (1)	million KWH	1,100			1,100	1,200			1,200
12	GRAND TOTAL	million KWH				3,900				4,200

(1) KWH equivalent of the fuels required to produce the electrical energy.

EXHIBIT V-2-2b
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume

SIC 2822 Industry Synthetic Rubber

Process Butyl Rubber

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion cu. ft.	2.5			2.5	3.7			3.7
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	256			256	371			371
12	GRAND TOTAL									

EXHIBIT V-2-3b
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in BTU's

SIC 2822 Industry Synthetic Rubber

Process Butyl Rubber

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion BTU s	2,600			2,600	3,800			3,800
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTU s	2,700			2,700	3,900			3,900
12	GRAND TOTAL	billion BTU s				5,300				7,700

EXHIBIT V-2-4b
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalent

SIC 2822 Industry Synthetic Rubber

Process Butyl Rubber

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	million KWH	760			760	1,100			1,100
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)(1)	million KWH	790			790	1,150			1,150
12	GRAND TOTAL					1,550				2,250

(1) KWH equivalent of the fuels required to produce the electrical energy.

EXHIBIT V-2-2c
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume

SIC 2822 Industry Synthetic Rubber

Process Stereo Polybutadiene Elastomers

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion cu. ft.	7.3			7.3	9.4			9.4
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	150			150	190			190
12	GRAND TOTAL									

EXHIBIT V-2-3c
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in BTU's.

SIC 2822 Industry Synthetic Rubber

Process Stereo Polybutadiene Elastomers

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion BTU s	7,500			7,500	9,700			9,700
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTU s	1,600			1,600	2,000			2,000
12	GRAND TOTAL	billion BTU s				9,100				11,700

(1) KWH equivalent of the fuels required to produce the electrical energy.

EXHIBIT V-2-4c
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalent.

SIC 2822 Industry Synthetic Rubber

Process Stereo Polybutadiene Elastomers

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	million KWH	2,200			2,200	2,800			2,800
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased) (1)	million KWH	500			500	600			600
12	GRAND TOTAL	million KWH				2,700				3,400

(1) KWH equivalent of the fuels required to produce the electrical energy.

EXHIBIT V-2-2d
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume

SIC 2822 Industry Synthetic Rubber

Process Stereo Polyisoprene Elastomers

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion Cu. Ft.	3.0			3.0	2.9			2.9
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	57			57	56			56
12	GRAND TOTAL									

EXHIBIT V-2-33
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in BTU s

SIC 2322 Industry Synthetic Rubber

Process Stereo Polyisoprene Elastomers

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	billion BTU s	3,100			3,100	3,000			3,000
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTU s	600			600	600			600
12	GRAND TOTAL	billion BTU s				3,700				3,600

EXHIBIT V-2-4d
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalent.

SIC 2822 Industry Synthetic Rubber

Process Stereo Polyisoprene Elastomers

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas	million KWH	910			910	880			880
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)(1)	million KWH	180			180	170			170
12	GRAND TOTAL	million KWH				1,090				1,050

(1) KWH equivalent of the fuels required to produce the electrical energy.

EXHIBIT V-[illegible]
FEO: USDC
REQUIRED TABLE 5

Industry Consumption of Fuels, Petroleum Products, and Energy by Type - 1971, 1973, and 1974

SIC 2322 Industry Synthetic Rubber

Line No.	Type of Energy or Material	Unit of Measure	Volume (1)			Bil. BTUs (2)			% Change		% of Total BTU's	
			1971	1973	1974	1971	1973	1974	1971-73	1973-74	1971	1974
1	Propane, butane, and mixtures											
2	Middle distillates	1,000 barrels	162	175	180	900	1,100	1,100	11.0	10	[illegible]	1.2
3	Residual fuel oil	1,000 barrels	13.4	14.4	14.8	80	90	90	12.5	-	0.1	0.1
4	Chemical feedstocks											
5	Other petroleum, products, total (3)											
	· Extender oils	million pounds	690	780	800							
6	Petroleum products, total											
7	Coal	1,000 short tons	238	216	222	6,300	5,700	5,800	(9.6)	2	3.0	6.3
8	Natural gas	billion cu. ft.	49.0	57.7	59.3	50,600	59,600	61,200	17.8	3	64.7	66.3
9	Fuels, n.e.c. total (4)	million dollars	3.4	4.1	4.2	2,000	2,400	2,400	20	-	2.6	2.7
10	Other fuels, total											
11	Electrical energy (purchased only)	million KWH	1,920	1,925	1,976	18,400	20,400	21,000	10.9	3	23.4	22.9
12	GRAND TOTAL (Lines 6, 7, 8, 10)		(X)	(X)	(X)	78,300	89,200	91,600	13.9	2.7	100.0%	100.0%

Source: (1) Respective energy factors in Exhibit V-6 times total production on line 1, Exhibit V-4. For 1974, the average of the "low" and "high" production volume and the 1973 energy factor are used. Because of uncertainties in the pattern of fuel shifts and in the extent of potential conservation during 1974, the same energy factor was assumed for 1974 as for 1973.

(2) BTUs and Cu. Ft. of Natural Gas have been changed to billions from millions.

(3) Although this study deals with industrial energy use, volumetric data is provided on the use of extender oils, since these are directly subject to the Mandatory Petroleum Allocation Regulations. Estimates are based on census "Materials Consumed" data for 1972 from MC72(p) - 28B - 2 and Line 2 production data from Exhibit V-4.

(4) $x(170 KWH/$) x 3,413 BTU/KWH.

EXHIBIT V - 2-6a
FEO:USDC
REQUIRED TABLE 6

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit(1)

SIC 2822 Industry Synthetic Rubber Year 1971

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU's)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
1	United States		162	13.4			1,030	238	49.0	11.6	56,820	18,400	78,300
2	NORTH EAST												
3	New England												
4	Maine		-	-			-	-	-	-	-	-	-
5	N.H.		-	-			-	-	-	-	-	-	-
6	Vermont		-	-			-	-	-	-	-	-	-
7	Mass.		0.8	0.07			5	-	0.29	(Z)	300	95	410
8	R.I.		-	-			-	-	-	-	-	-	-
9	Conn.		2.7	0.22			17	-	0.92	(Z)	950	310	1,310
10	Middle Atlantic												
11	N.Y.		0.1	0.01			(Z)	-	0.03	(Z)	30	10	40
12	N.J.		-	-			-	-	-	-	-	-	-
13	Penn.		1.1	0.09			7	2.3	0.32	(Z)	390	130	530
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio		10.7	0.89			68	22.0	3.09	1	3,770	1,220	5,190
17	Ind.		-	-			-	-	-	-	-	-	-
18	Ill.		0.4	0.04			3	0.9	0.12	(Z)	150	50	210
19	Mich.		0.2	0.02			1	0.5	0.06	(Z)	80	30	110
20	Wisc.		-	-			-	-	-	-	-	-	-
21	W. North Central												
22	Minn.		-	-			-	-	-	-	-	-	-
23	Iowa		-	-			-	-	-	-	-	-	-
24	Mis.		-	-			-	-	-	-	-	-	-
25	N.D.		-	-			-	-	-	-	-	-	-
26	S.D.		-	-			-	-	-	-	-	-	-
27	Neb.		-	-			-	-	-	-	-	-	-
28	Kansas		-	-			-	-	-	-	-	-	-

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.
Source: (1) Figures for United States from Exhibit V-2-5. Figures for petroleum products, purchased electrical energy and fuels, n.e.c. for individual states are Snell estimates based upon distribution of production capacities among the producing states. Coal consumption has been assigned only to major coal producing states as shown in Exhibit V-10 and natural gas consumption has been assigned to make up the difference in energy consumption of all producing states.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU's)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU's)*	Total (Bil. BTU's)*	Purchased Electrical Energy (Bil. BTU's)*	Grand Total (Bil. BTU's)*
29	SOUTH												
30	S. Atlantic												
31	Del.		1.1	0.09			7	-	0.38	(Z)	390	130	530
32	Md.		-	-			-	-	-	-	-	-	-
33	D.C.		-	-			-	-	-	-	-	-	-
34	Va.		-	-			-	-	-	-	-	-	-
35	W. Va.		-	-			-	-	-	-	-	-	-
36	N.C.		1.3	0.11			8	-	0.46	(Z)	470	150	640
37	S. C.		-	-			-	-	-	-	-	-	-
38	Ga.		1.6	0.13			10	-	0.54	(Z)	560	180	770
39	Fla.		-	-			-	-	-	-	-	-	-
40	S. Central												
41	Ky		19.2	1.58			122	39.3	5.51	1	6,720	2,160	9,250
42	Tenn.		1.7	0.14			11	3.4	0.48	(Z)	580	190	800
43	Ala.		-	-			-	-	-	-	-	-	-
44	Miss.		-	-			-	-	-	-	-	-	-
45	Ark.		-	-			-	-	-	-	-	-	-
46	La.		37.5	3.10			238	-	12.75	3	13,160	4,240	18,110
47	Okla.		-	-			-	-	-	-	-	-	-
48	Texas		82.6	6.83			525	169.6	23.77	6	28,970	10,375	39,870
49	WEST												
50	Mountain												
51	Mont.		-	-			-	-	-	-	-	-	-
52	Idaho		-	-			-	-	-	-	-	-	-
53	Wyo.		-	-			-	-	-	-	-	-	-
54	Colo.		-	-			-	-	-	-	-	-	-
55	N.M.		-	-			-	-	-	-	-	-	-
56	Ariz.		-	-			-	-	-	-	-	-	-
57	Utah		-	-			-	-	-	-	-	-	-
58	Nev.		-	-			-	-	-	-	-	-	-

* BTU's & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT V - 2-6c

		Petroleum Products						Other Fuels					
Line Number	Geographic Unit	Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
59.	Pacific												
60	Wash.		-	-			-	-	-	-	-	-	-
61	Ore.		-	-			-	-	-	-	-	-	-
62	Cal.		0.9	0.08			6	-	0.31	(Z)	320	100	440
63	Alas.		-	-			-	-	-	-	-	-	-
64	Haw.		-	-			-	-	-	-	-	-	-

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT V-2-7a
FEO:USDC
REQUIRED TABLE 7

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit (1)

SIC 2822 Industry Synthetic Rubber Year 1973

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
1	United States		175	14.4			1,110	216	57.7	14.0	65,220	20,400	89,200
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.		0.9	0.07			6		0.32	(Z)	330	100	450
8	R.I.												
9	Conn.		2.8	0.23			13		1.03	(Z)	1,060	330	1,460
10	Middle Atlantic												
11	N.Y.		0.1	0.01			1		0.03	(Z)	30	10	40
12	N.J.												
13	Penn.		1.2	0.10			7	2.0	0.37	(Z)	430	135	590
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio		11.3	0.93			71	19.2	3.57	1	4,190	1,310	5,770
17	Ind.												
18	Ill.		0.5	0.04			3	0.8	0.14	(Z)	170	50	230
19	Mich.		0.2	0.02			1	0.4	0.08	(Z)	90	30	120
20	Wisc.												
21	W. North Central												
22	Minn.												
23	Iowa												
24	Mis.												
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT [illegible]

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.		1.2	0.1			7		0.42	(Z)	430	135	590
33	D.C.												
34	Va.												
35	W. Va.												
36	N.C.												
37	S. C.		1.4	0.11			9		0.50	(Z)	520	160	710
38	Ga.												
39	Fla.		1.7	0.14			11		0.61	(Z)	630	195	960
40	S.Central												
41	Ky												
42	Tenn.		20.6	1.69			131	35.1	6.54	2	7,670	2,400	10,570
43	Ala.		3.5	0.29			22	5.9	1.11	(Z)	1,300	405	1,780
44	Miss.												
45	Ark.												
46	La.												
47	Okla.		39.3	3.23			249		14.19	3	14,640	4,580	20,160
48	Texas		89.6	7.37			568	152.7	28.47	7	33,380	10,430	45,960
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Petroleum Products: Distillates (Thousand Barrels)	Petroleum Products: Residual (Thousand Barrels)	Petroleum Products: Feedstocks (Thousand Barrels)	Petroleum Products: Other (Thousand Barrels)	Petroleum Products: Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Other Fuels: Natural Gas (Bil. Cu. Ft.)*	Other Fuels: Fuels n.e.c. (Bil. BTU s)*	Other Fuels: Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
59	Pacific												
60	Wash.												
61	Ore.												
62	Cal.		1.0	0.08			6		0.35	(Z)	360	110	490
63	Alas.												
64	Haw.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

(1) Figures for United States from Exhibit V-2-5. Figures for petroleum products, purchased electrical energy and fuels, n.e.c., for individual states are Snell estimates based upon distribution of production capacities among the producing states. Coal consumption has been assigned only to major coal producing states as shown in Exhibit V-10 and natural gas consumption has been assigned to make up the difference in energy consumption of all producing states.

EXHIBIT V-2-8a
FEO:USDC
REQUIRED TABLE 8

Shipments, Employment, and Fuels and Energy Consumed by Geographic Unit, 1971 and 1973

SIC 2822 Industry Synthetic Rubber

Line Number	Geographic Unit	Value of Shipments (1) ($ Millions)			Employment (2)			Fuels and Energy (3) (Bil. BTU s)*		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
1	United States	1,043	1,113	6.7	10,729	9,900	(7.7)	78,300	89,200	14.8
2	NORTH EAST									
3	New England									
4	Maine									
5	N.H.									
6	Vermont									
7	Mass.	5.4	5.6	3.7	56	50	(11)	410	450	9.8
8	R.I.									
9	Conn.	17.4	18.1	4.0	179	161	(10)	1,310	1,460	11.5
10	Middle Atlantic									
11	N.Y.	0.5	0.5	0	5	5	0	40	40	0
12	N.J.				(D)(4)	(D)(4)				
13	Penn.	7.1	7.4	4.2	73	66	(9.6)	530	590	11.3
14	NORTH CENTRAL									
15	E. North Central									
16	Ohio	69.2	71.6	3.5	712	637	(11)	5,190	5,770	11.2
17	Ind.									
18	Ill.	2.8	2.9	3.6	29	26	(10)	210	230	9.5
19	Mich.	1.4	1.5	7.1	15	13	(13)	110	120	9.1
20	Wisc.									
21	W. North Central									
22	Minn.									
23	Iowa									
24	Mis.									
25	N.D.									
26	S.D.									
27	Neb.									
28	Kans.									

* BTU s and Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT V-2-8b

Line Number	Geographic Unit	Value of Shipments (1) ($ Millions)			Employment (2)			Fuels and Energy (3) (Bil. BTU s) *		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
29	SOUTH									
30	S. Atlantic									
31	Del.	7.1	7.4	4.2	73	66	(9.6)	530	590	11.3
32	Md.									
33	D.C.									
34	Va.									
35	W. Va.									
36	N.C.	8.5	8.8	3.5	88	79	(10)	640	710	10.9
37	S.C.									
38	Ga.	10.3	10.7	3.9	106	95	(10)	770	860	11.7
39	Fla.									
40	S. Central									
41	Ky.	123.3	131.0	6.2	1,269	1,165	(8.2)	9,250	10,570	14.3
42	Tenn.	10.7	22.1	107	110	197	79	800	1,780	123
43	Ala.									
44	Miss.									
45	Ark.									
46	La.	241.5	249.9	3.5	2,484	2,223	(11)	18,110	20,160	11.3
47	Okla.									
48	Texas	531.7	569.6	7.1	5,470	5,066	(7.4)	39,870	45,960	15.3
49	WEST									
50	Mountain									
51	Mont.									
52	Idaho									
53	Wyo.									
54	Colo.									
55	N.M.									
56	Ariz.									
57	Utah									
58	Nev.									

* BTU s and Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT V-2-8c

Line Number	Geographic Unit	Value of Shipments (1) ($ Millions)			Employment (2)			Fuels and Energy (3) (Bil. BTU s)*		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
59	Pacific									
60	Wash.									
61	Ore.									
62	Cal.	5.9	6.1	3.4	60	54	(10)	440	490	11.4
63	Alas.									
64	Haw.									

* BTU s and Cu. Ft. of Natural Gas have been expressed in Billions rather in Millions.

Source: (1) Figures for United States from Exhibit V-3. Figures for individual states are Snell estimates based upon distribution of capacity throughout the United States (calculated in same manner as was the employment distribution in Exhibit V-8).
(2) Exhibit V-8.
(3) Figures for United States from Exhibit V-2-5. Figures for individual states are Snell estimates based upon distribution of capacity throughout the United States (calculated in same manner as was the employment distribution in Exhibit V-8).
(4) Unquantified employment reported in County Business Patterns for 1971 and 1972, but no major plant reported in International Institute of Synthetic Rubber Producers' report.

EXHIBIT V - 2-9
FEO: USDC
REQUIRED TABLE 9

Stocks of Fuels and Petroleum Products by Type, 12/31/73 and 3/31/74

SIC 2822 Industry Synthetic Rubber

Line Number	Type of Energy or Material	Stocks (# of days supply related to average daily requirements in next quarter)(1)					
		As of December 31			As of March 31		
		1971	1972	1973	1972	1973	1974
1	Propane (2)	2	2	2	2	2	2
2	Butane (3)	30	17	34	25	8	24
3	Propane Butane Mixture	14	14	7	14	14	7
4	Middle Distillates	15	20	25	15	20	25
5	Residual Fuel Oil						
6	Chemical Feedstocks	< 2	< 2	< 2	< 2	< 2	2 (even)
7	Other Petroleum Products (total)(4)						
	Butadiene	6	6	3	6	6	2
	Styrene	20	15	14	20	18	18
	Propylene(3)	26	5	10	64	52	10
	Extender oil	8	6	6	8	8	8
	Carbon black	13	16	8	14	14	9
8	Coal (3)	90	60	75	90	60	90
9	Natural Gas	0	0	0	0	0	0
10	Fuels, n.e.c., total						
	By-product gas	0	0	0	0	0	0

Source: (1) From replies to limited survey handled through the International Institute of Synthetic Rubber Producers, Inc.

(2) Two respondents (not included in these figures) have pipeline supply from captive production.

(3) One respondent only.

(4) Representative but not all-inclusive list.

EXHIBIT V - 2-12
FEO: USDC
REQUIRED TABLE 12

Seasonal Use of Fuels, Petroleum Products and Energy by Type, 1973 (1)

SIC 2822 Industry Synthetic Rubber

Line Number	Type of Material or Energy	Percent of Annual Use in 1973 in			
		Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.
1	Propane, butanes and mixtures (2)	20/38	20/21	28/28	32/13
2	Distillates (2)	14/85	25/0	28/0	33/15
3	Residual				
4	Feedstocks	25	25	25	25
5	Other Petroleum Products				
	Butadiene	25	25	25	25
	Styrene	25	25	25	25
	Propylene (3)	22	8	32	38
	Extender oil	25	25	25	25
6	Coal (3)	33	21	17	29
7	Natural Gas	25	25	25	25
8	Other Fuels				
	By-product gas (3)	32	27	25	16
9	Electrical Energy (purchased)	25	25	25	25

Source: (1) From replies to limited survey handled through the International Institute of Synthetic Rubber Producers, Inc.
(2) Example of responses from two respondents.
(3) One respondent only.

EXHIBIT V-3
FEO: USDC
SIC 2822 - VALUE OF SHIPMENTS --1967, 1971-1974
(Millions of Dollars)

Line	Item	1967	1971	1972	1973	1974[6] Low	1974[6] High
1.	Total value of products and services sold by SIC 2822 industry[1]	$ 926.9	$1,042.6	$1,089.3	$1,113.4	$1,391	$1,488
2.	Value of SIC 2822 products shipped by SIC 2822 industry[2]	814.4	864.9	950.0	971.0	1,214	1,299
3.	Total value of SIC 2822 products shipped by all industries[3]	1,004.9	1,153.2	1,288.6	1,317.1	1,646	1,760
4.	Ratio of value of SIC 2822 products shipped by SIC 2822 industry to value of SIC 2822 products shipped by all industries (coverage ratio)[4]	0.81	0.75	0.74	0.74	0.74	0.74
5.	Value of shipments of various SIC 2822 products by SIC 2822 industry[5]						
	S-type rubber	$ 423.5	$ 471.2	$ 427.4	$ 388.2	$ 485	$ 497
	Butyl rubber	74.9	57.1	58.1	64.6	81	86
	N-type rubber	54.4	50.3	57.8	58.5	73	78
	Stereo polybutadiene elastomers	72.4	71.2	85.3	87.0	109	116
	Stereo polyisoprene elastomers	51.0	35.3	42.0	46.0	57	58
	Ethylene propylene elastomers		28.9	37.9	53.3	67	93
	Other elastomers	138.2	150.9	241.5	273.4	342	371

Footnotes:

(1) Figures for 1967, 1971 and 1972 obtained from Sources (a), (b), and (c). Figures for 1973 and 1974 obtained from values in line 2 using 1972 ratio of total value of products and services sold by SIC 2822 industry to value of SIC 2822 products shipped by the industry.

(2) Figures for 1967, 1971 and 1972 obtained from values in line 3 using ratios given in line 4. Figures for 1973 and 1974 are sums of figures for individual product categories.

(3) Figures for 1967, 1971 and 1972 obtained from Sources (a), (d), and (c). Figures for 1973 and 1974 obtained from values in line 2 using ratio given in line 4.

(4) Ratios for 1967 and 1972 obtained from Sources (a) and (c). Ratio for 1971 obtained from interpolation of 1967 and 1972 figures. It is assumed that this ratio is constant from 1972 to 1974.

(5) All figures calculated from quantity shipments using best estimate of product prices. Total quantity shipments for all producers have been modified by ratio given in line 4 to obtain estimate of quantity shipments of each product category by SIC 2822 industry. Quantity shipments for 1971 and 1972 obtained from Source (e) using formula: quantity produced + stocks end of previous year - stocks end of current year. Quantity shipments for 1967 and 1973 obtained respectively, from 1971 figures using ratio of quantities produced in the two years (Sources (e) and (f)) and from 1972 figures using ratio of quanties consumed in the two years (Sources (e) and (g)).

(6) Figures for 1974 built up from individual product category figures which are estimated to range from a minimum of zero growth to a maximum of a continuation of the historical growth rate of quantities shipped from 1967 to 1973. All figures reflect a price increase of 25%.

Sources:

(a) "Industry Statistics," 1967 Census of Manufactures, U.S. Department of Commerce, Vol. II, Part 2, Major Groups 25-33, pp. 30A1-33.
(b) "Value of Product Shipments" Annual Survey of Manufacturers - 1971, U.S. Department of Commerce, Publication M 21 (AS)-2, October 1973.
(c) "Synthetic Rubber, SIC 2822," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC72(P)-28B-2, January 1974.
(d) "General Statistics for Industry Groups and Industries," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC72(A)-1.
(e) "Rubber: Supply and Distribution for the United States "Current Industrial Reports (1972), U.S. Department of Commerce, Series: M30A (72-13, December 1973.
(f) "Chemical Statistics Handbook" Manufacturing Chemists Association, Washington, pp. 138-9.
(g) "Industry Rubber Report," Rubber Manufacturers Association, Inc., New York, February 6, 1974.
(h) "Outlook '73 for Suppliers to the Rubber Industry," Rubber World, February 1973, p. 35.
(i) "Synthetic Organic Chemicals - U.S. Production and Sales, 1971," U.S. Tariff Commission, TC Publication 614, p. 151.

EXHIBIT V-4

FEO: USDC

SIC 2822 - PRODUCTION VOLUME - 1967, 1971 TO 1974

(Millions of Pounds)

Line	Item	1967	1971	1972	1973	1974[6] Low	1974[6] High
1.	Total production of SIC 2822 industry[1]	4,036.7	4,457.4	4,509.3	4,808.4	4,807	5,074
2.	Production of SIC 2822 products by SIC 2822 industry[2]	3,546.8	3,697.7	3,932.6	4,193.5	4,193	4,425
3.	Total production of SIC 2822 products by all industries[3]	4,376.4	4,930.2	5,334.3	5,688.1	5,687	6,003
4.	Ratio of production of SIC 2822 products by SIC 2822 industry to production of SIC 2822 products by all industries[4]	0.81	0.75	0.74	0.74	0.74	0.74
5.	Production of major SIC 2822 products by SIC 2822 industry:[5]						
	S-type rubber	1,909.2	2,337.1	2,394.2	2,453.1	2,453	2,514
	Butyl rubber	215.2	175.7	209.7	255.3	255	273
	N-type rubber	116.6	107.9	119.0	134.5	135	143
	Stereo polybutadiene elastomers	380.8	418.7	488.9	537.8	538	571
	Stereo polyisoprene elastomers	200.0	192.2	213.5	189.5	188	190
	Ethylene propylene elastomers		99.2	146.4	191.5	192	266
	Other elastomers	725.0	367.0	360.9	431.8	432	468

(1) Figures given in "equivalent" production of SIC 2822 products calculated from figures in line 2 by applying ratio of the total value of SIC 2822 products and services sold by SIC 2822 industry to the value of SIC 2822 products shipped by the industry (see Exhibit V-3)
(2) Figures calculated from quantities in line 3 using ratios given in line 4.
(3) Figures for 1967 obtained from Source (a) and for 1971 - 1973 from Source (b).
(4) Ratios are those which were established for the value of shipments for this industry (see Exhibit V-3).
(5) Figures for 1967 obtained from Source (d) and for 1971-1973 from Source (b) modified by ratios given in line 4.
(6) Figures for 1974 built up from quantities estimated for individual product categories which are estimated to range from quantities given by no growth from 1973 to a continuation of the historical growth rate (positive or negative) from 1971 to 1973.

Sources:
(a) "Chemical Statistics Handbook" Manufacturing Chemists Association, pp. 138-9.
(b) "Rubber: Supply and Distribution for the United States," Current Industrial Reports (1972), Series M30A(72)-13, U.S. Department of Commerce, Bureau of Census, December 1973.
(c) "Industry Statistics," 1967 Census of Manufactures, U. S. Department of Commerce, Vol. II, Part 2, Major Groups 25-33, 1971, pp. 28B1-25.
(d) "Synthetic Rubber, SIC 2822," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC 72 (P)-28B-2, January 1974.
(e) "U.S. Production and Sales of Rubber, 1975," Synthetic Organic Chemicals, U.S. Tariff Commission, TC Publication 614, p. 151.
(f) "Industry Rubber Report," Rubber Manufacturers Association, Inc., February 6, 1974.
(g) "Outlook '73 for Suppliers to the Rubber Industry," Rubber World February 1973, p. 35.

EXHIBIT V-5
FEO: USDC
SIC 2822 - ENERGY FACTORS FOR MAJOR PROCESSES - REPRESENTATIVE DATA[1]

(Per Million Pounds Produced)

	Electricity (Million KWH)	Natural Gas (Billion Cu. Ft.)	BTUs (Billions)	KWH Equivalents[5] (Millions)
S-type Rubber[2]	0.154	0.004	5.8	1.69
Butyl Rubber[3]	1.456	0.0143	30.3	8.85
Stereo Polybutadiene Elastomers[4]	0.356	0.0174	21.8	6.38
Stereo Polyisoprene Elastomers[4]	0.296	0.0155	19.2	5.62

Source:
(1) Variations around these values can be significant from plant-to-plant as a function of age, design and operations.
(2) Personal communication from K. Stern, author of article on this subject published in Rubber World, December 1973.
(3) Data supplied by the Conference Board, including the assumption of the use of natural gas to produce the steam required.
(4) Snell estimates based on data supplied by the Conference Board, including, in addition to the natural gas usage assumption, Snell estimates of the mix between various processes.
(5) This includes a conversion factor of 3.1 KWH equivalent per KWH of electrical energy to account for the fuels required to produce the electrical energy.

EXHIBIT V-6
FEO: USDC

SIC 2822 - INDUSTRY LEVEL ENERGY FACTORS -
1967, 1971, 1973
(Units Per Million Equivalent Pounds of Rubber Produced)

Item	Units	Year 1967 (1)	1971 (1)	1973 (2)
Total production of SIC 2822 industry (3)	Million equivalent pounds	4,036.7	4,457.4	4,808.4
Coal	Short tons	70.3	53.4	45.0
Fuel Oil				
Distillate	Barrels	(NA)	36.4	36.4
Residuals	Barrels	(NA)	3.0	3.0
Natural Gas	Million cu. ft.	9.0	11.0	12.0
Other fuels	Dollars	595	763	847
Fuels, n.s.k.	Dollars	149	-	
Purchased Electricity (4)	Million KWH	0.39	0.39	0.4
BTU equivalents of purchased electricity	Billion BTUs	4.13	4.13	4.2
BTU equivalents of fuels and purchased electricity	Billion BTUs		17.55	18.41

(1) Figures for 1967 and 1971 are the quotient of census data from "Fuels and Electric Energy Consumed", MC 67(S) 74 and MC 72 (SR)-6 respectively divided by total equivalent production of SIC 2822 industry. An exception is 1971 electricity, explained in footnote (4).
(2) Based on extrapolation of 1967 to 1971 census trend in coal, natural gas and dollar quantified items and assumption that the 1971 and 1973 factors for fuel oils were the same.
(3) Equivalent production figures from Exhibit V-4, line 1.
(4) Since product mix, shown in Exhibit V-7, shows an increase in the share of the relatively less electricity intensive S-Type rubber from 1967 to 1971, no increase in the electricity factor is assumed to parallel the increase in the fuel factors.

EXHIBIT V-7
FEO: USDC
SIC 2822 - PRODUCT MIX - 1967, 1971-1973

Line	Item	Year			
		1967	1971	1972	1973
		Million Lbs.			
1	Total production by SIC 2822 industry	4,037	4,457	4,509	4,808
		Percent Total Product by Weight			
2	S-Type rubber	47.3%	52.4%	53.1%	51.0%
3	Butyl rubber	5.3	3.9	4.7	5.3
4	N-Type rubber	2.9	2.4	2.6	2.8
5	Stereo-Polybutadiene elastomers	9.4	9.4	10.8	11.2
6	Stereo-Polyisoprene elastomers	5.0	4.3	4.7	3.9
7	Ethylene-Propylene elastomers		2.2	3.2	4.0
8	Other elastomers	18.0	8.2	8.0	9.0
9	Other	12.1	17.2	12.9	12.8

Source: Snell estimates based on the data in Exhibit V-4.

EXHIBIT V-8

FEO: USDC

SIC 2822 - CAPACITY AND EMPLOYMENT PER STATE--1971 AND 1973

State	Estimated Production Capacity (Long Tons)[1]		Estimated Number of Employees[2]	
	1971	1973	1971	1973
United States	2,929,150	3,021,050	10,729	9,900
California	16,500	16,500	60	54
Connecticut	49,000	49,000	179	161
Delaware	20,000	20,000	73	66
Georgia	29,000	29,000	106	95
Illinois	7,800	7,800	29	26
Kentucky	346,400	355,500	1,269	1,165
Louisiana	678,250	678,250	2,484	2,223
Massachusetts	15,300	15,300	56	50
Michigan	4,000	4,000	15	13
North Carolina	24,000	24,000	88	79
New York	1,400	1,400	5	5
Ohio	194,250	194,250	712	637
Pennsylvania	20,000	20,000	73	66
Tennessee	30,000	60,000	110	197
Texas	1,493,250	1,546,050	5,470	5,066

Source: (1) "Synthetic Rubber World Production Facilities," The Rubber Industry Statistical Report, International Institute of Synthetic Rubber Producers, Inc., New York, N.Y., 1973, Appendix B.

(2) Figures for United States from Exhibit V-9. Figures for individual states are Snell estimates based upon distribution of production capacities among producing states.

EXHIBIT V-9

FEO:USDC

SIC 2822-TOTAL PRODUCTION AND EMPLOYMENT--1971 TO 1973

Year	Total Production of SIC 2822 Industry[1] (million pounds)	Total Employment in SIC 2822 Industry
1971	4,457	10,729[2]
1972	4,509	9,852[2]
1973	4,808	9,900[3]

Source: (1) Data from Exhibit V-4, line #1.
(2) County Business Patterns, 1971 and 1972.
(3) Snell estimate confirmed by interviews.

EXHIBIT V-10
FEO:USDC
SIC 2822 - DISTRIBUTION OF COAL
CONSUMPTION--1971 AND 1973

State	Estimated Production Capacity of Coal Producing States (Long Tons)(1)		Estimated Consumption of Coal (Short Tons) (2)	
			1971	1973
United States	2,095,700	2,187,600	238,000	216,000
Illinois	7,800	7,800	890	770
Kentucky	346,400	355,500	39,340	35,100
Michigan	4,000	4,000	450	390
Ohio	194,250	194,250	22,060	19,180
Pennsylvania	20,000	20,000	2,270	1,970
Tennessee	30,000	60,000	3,410	5,920
Texas	1,493,250	1,546,050	169,580	152,650

(1) "Synthetic Rubber World Production Facilities," The Rubber Industry Statistical Report, International Institute of Synthetic Rubber Producers, Inc., New York, N.Y., 1973, Appendix B.

(2) It is assumed that all of the coal consumed by this industry is consumed by the major coal producing states with synthetic rubber production facilities and distributed throughout them according to their synthetic rubber production capacities.

SECTION VI

SIC 2823, CELLULOSIC MAN-MADE FIBERS

Exhibit VI-1 at the end of this section, presents a detailed industry definition. In 1971 value added by manufacture was $350 million according to the Annual Survey of Manufactures, while value of shipments was $662 million and total gross book value of depreciable assets was $624 million. The same source reports fuel consumption of 23.5 billion KWH equivalents. County Business Patterns, 1972, reports that about 25 establishments were classified in SIC 2823. There are 16 major plants.

The most important findings follow regarding the economic impact of the petroleum based materials shortages during 1973 and the first quarter of 1974.

- Fuel shortages were of concern but did not cause serious disruptions
- The major raw materials of this industry are not petroleum based
- There has been a historical attrition in employment and continuation of the trend during 1974 was projected
- No major near-term opportunities for substitution or conservation of fuels were defined
- Rayon manufacture is more energy efficient than acetate fibers production

Exhibit VI-2, following Exhibit VI-1, features the Required Tables. These tables and supporting exhibits further define the industry's structure both in economic and energy terms.

All exhibits appear sequentially at the end of this section. Whenever electricity KWHs are expressed as BTUs, conversion is based on the nominal fuel requirements to generate the electricity.

1. MAJOR USES OF FUELS, ENERGY AND PETROLEUM PRODUCTS

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

1.1 Task I, Major Processes

There are two major processes in the industry, the manufacture of rayon fibers and the manufacture of acetate fibers.

Rayon is produced by regeneration of natural polymer cellulose from one or another of its chemical derivatives. Rayon is a natural product which has been chemically treated so that filaments or sheets can be obtained with the usual spinning and casting techniques.

- The viscose process for making rayon, the last of three commercial processes to be developed, is by far the most important. The process is rather lengthy (taking several days to a week) and requires careful control throughout; yet all the raw materials are fairly cheap, with the result that viscose rayon can generally be made to sell below the price of all other rayons.

- Rayon polymer is produced by treating wood pulp with caustic soda and then with carbon disulfide. The resulting new compound, when dissolved in caustic soda, produces a solution which contains the viscose rayon. Polymer manufacture includes the following steps:

  - steeping of the raw materials to produce a soda cellulose

  - shredding into a crumb

  - aging of the crumb

- After aging, the rayon polymer goes through various mixing and ripening steps to prepare it for spinning into fiber. Manufacturing steps in this part of the process include:

- mixing with carbon disulfide to produce cellulose xanthate

- mixing with sodium hydroxide to form the solution

- ripening

- production of rayon fibers

- washing, drying, and winding of the fibers on bobbins.

Acetate fiber is a partially acetylated cellulose. The manufacturing process involves first the production of cellulose acetate followed by the production of the acetate fibers.

. Cellulose acetate is produced from wood pulp through the acetylation of acetic anhydride in the presence of glacial acetic acid or methylene chloride. Polymer manufacture includes the following steps:

  - pretreatment of the cellulose with acetic acid or methylene chloride

  - acetylation

  - hydrolysis

  - recovery of the polymer in a precipitator

  - washing and drying

. The primary method for manufacturing acetate fiber from the cellulose acetate flake is through a dry extrusion type process. This process includes the following steps:

  - dissolving the cellulose acetate flake in a volatile solvent

  - pumping the solution through a spinneret

- evaporation of the solvent to form the fibers
- stretching, drawing, or twisting operations
- winding the fibers on bobbins.

1.2 Task II, Industry Output

Exhibit VI-3 presents value of shipments for recent years. In 1971 the value of all products and services sold by SIC 2823 industry was $662 million. This was approximately $707 million in 1973. Production, shown in Exhibit VI-4, was about 1,350 million equivalent pounds in 1971. This decreased to about 1,240 million pounds in 1973.

Exhibit VI-2-1 presents Required Table 1, showing that rayon and acetate fibers are the major products of the industry, accounting in 1973 for about 65% and 34% of production, respectively.

1.3 Task III, Energy Related Profile of Major Processes

Exhibit VI-5 summarizes the results of a survey by the Textile Economics Bureau of fuels and electricity use by the man-made fiber industry. The table below summarizes unit BTU requirements for rayon and acetate .

	Energy Consumed Per Lb Of Product, BTU	
Year	Rayon	Acetate
1971	62,000	67,000
1973	50,000	63,000

The significant reduction in the energy requirement of rayon from 1971 to 1973 is probably accounted for by the following

- according to Textile Economics Bureau data, rayon textile yarn production decreased from 1971 to 1973 from 303 million lbs to 198 million lbs; rayon staple increased from 612 million lbs to 697 million lbs; yarn production is more energy intensive than staple production
- capacity utilization was higher in 1973 than in 1971
- the 1973 data is based on more extensive (97%) sampling of the industry than the 1971 data (76%). See Exhibit VI-5.

- fuel shifts

Based on the data of Exhibit VI-5, energy use profiles were developed for the manufacture of rayon and acetate. These appear in the Required Tables, shown in Exhibits VI-2-2, 3 and 4, series "a" and "b" respectively. There was a significant shift from coal use to increased purchased electricity in rayon manufacture from 1971 to 1973.

1.4 Task IV, Shifts In The Energy Related Profile of The Industry - 1971 to 1973

Exhibit VI-6 presents industry level energy factors for SIC 2823 based on census and the industry survey data of Exhibit VI-5. In 1971 the overall energy requirements per pound of product (~60,000 BTUs) were roughly the same from census data as from industry survey data. However, the industry survey indicates appreciably lower usage of natural gas and higher usage of coal and residual oil than census. The 1973 energy factors are based on the industry survey data and indicate a roughly 10% lower energy requirement per pound of product in 1973 than in 1971. Product mix did not change appreciably from 1971 to 1973, as shown in Exhibit VI-7.

Exhibit VI-2-5 presents Required Table 5. From 1971 to 1973 about 18% reduction occurred in the energy requirements of SIC 2823 industry. In 1971 approximately 81,000 billion BTUs were consumed, while in 1973 this was 68,000 billion BTUs. From 1971 to 1973 significant fuel shifts are reported, from coal and natural gas to purchased electricity and fuel oils.

1.5 Task V, Projected 1974 Energy Related Profile Of The Industry

The 1974 fuel and purchased electricity projections of Exhibit VI-2-5 are based on the average of the "high" and "low" production figures of Exhibit VI-4, Line 2, multiplied by the 1973 energy factors of Exhibit VI-6. The expected 1974 energy requirement of SIC 2823 industry is about 66,000 billion BTUs, down about 3% from 1973.

In 1974 coal is expected to continue to be the major fuel, accounting for roughly 70% of energy needs.

The projected 1974 raw materials profile of the industry is summarized below on the basis of the average expected 1974 production from Exhibit VI-4.

Fiber and Principal Intermediates	Lb Intermediate per Lb Product[1]	1974 Average Production (Million lbs)	SIC 2823[2] 1974 Intermediate Requirement (Million lbs)
Rayon			
. Chemical Cellulose	1.05	785	824
Acetate		395	
. Chemical Cellulose	0.67		265
. Acetic Anhydride	0.93		367

(1) Source: Textile Economics Bureau
(2) Snell estimates representing about 90% of the industry's average 1974 requirement.

2. GEOGRAPHIC PATTERN OF USE

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

2.1 Task I, Geographic Pattern of the Industry's Energy Related Profile - 1971 to 1973

SIC 2823 industry is concentrated in the South Atlantic states. The Required Tables in Exhibits VI-2-6 and 7 provide rough estimates of the geographic distribution of the industry's energy use for 1971 and 1973 respectively.

2.2 Task II, Geographic Pattern of Employment and Shipments - 1971 to 1973

Employment and origins of shipments are concentrated in the South Atlantic states. Snell's estimates of employment patterns were used as the basis for distributing industry level energy and shipment statistics to individual states. Exhibit VI-2-8 presents the Required Table on employment and shipments. The following exhibits support the derivation of these data:

- Exhibit VI-8, employment in the fibers industry (cellulosic and synthetic fibers)
- Exhibit VI-9, rayon and acetate plant and employment distribution by state.

At the industry level 1971 to 1973 shifts were as follows:

- There was about a 7 percent increase in the value of products and services sold by SIC 2823 industry (Exhibit VI-3)
- There was about an 18% reduction in employment
- There was about a 17% reduction in the levels of fuels and purchased electricity consumed.

2.3 Task III, Shifts in the Patterns

Between 1971 and 1973 no major new plant location has emerged. There was a slight decrease in production. Based on this and the assumptions presented in Exhibits VI-8 and VI-9, Exhibit VI-2-8 shows no geographic shifts in the pattern of value of shipments, employment or BTU requirements.

3. FUEL AND ENERGY SUPPLY SITUATION

The principal outputs from the tasks of this subsection are analysis of findings.

3.1 Task I, "Normal" Stocks of Materials

There are no significant quantities of petroleum based raw materials used by this industry, except acetic anhydride which was not in short supply in 1973. Exhibit VI-2-9, Required Table 9, presents data on stocks of coal, distillates and residual fuel oils.

3.2 Task II, Shifts in Stocks

No "dangerous" shifts in fuel stocks were reported by industry sources.

3.3 Task III, Captive Use

Exhibit VI-5 shows that in 1973 about 88% of the electricity required in rayon manufacture was captively generated. This was about 70% for acetate fibers manufacture.

No quantified data was identified on captive production of fuels, and therefore, Required Table 10 is not available.

3.4 Task IV, Sources of Supply

SIC 2823 industry derives about three-fourths of its energy needs from coal, mostly locally obtained in the South Atlantic states.

3.5 Task V, Proportion By Type of Supplier

Only qualitative information was identified regarding the proportion of fuels by type of supplier, and therefore Required Table 11 is not available. Suppliers include refineries, wholesalers of fuel oils, mixing companies, etc.

3.6 Task VI, Seasonality of Use

There is a seasonal variation in the consumption of fuels for the production of energy.

Total BTU consumption of energy varies about $\pm$ 8% from the arithmetic means of the seasonal extremes.

- greatest consumption is in the summer

- least consumption is in the spring and fall followed closely by the consumption in the winter months.

Electricity consumption varies about $\pm$ 20% from the arithmetic mean of the seasonal extremes.

- greatest consumption is in the summer

- least consumption is in the winter, followed closely by the consumption in the spring and fall months.

Heating requirements in the winter cancel to a certain degree the lower electricity requirements in these months in determining total consumption of fuels.

Since the industry is concentrated mainly in the South Atlantic states, the seasonal variations in fuel consumption at the industry level is characteristic of that area.

Required Table 12 is not presented because insufficient data was developed to quantify these trends as a function of specific fuel categories.

4. SUBSTITUTABILITY AND CONSERVATION OF MAJOR FUELS AND PETROLEUM PRODUCTS

The findings under this section were developed through the assistance of a technical industry spokesman working with the Textile Economics Bureau, review of secondary sources and review of in-house information.

4.1 Task I, Major Processes

There is little feasibility for the substitution of raw materials. Since yields are already 95% or better due to the highly competitive nature of the industry, the opportunity for conservation of raw materials is limited.

There is a reasonable degree of flexibility in fuels substitution.

- Shift from coal to oil, gas or other fuels is possible
- Shift back to coal is possible in facilities originally designed for coal use
- Shift to coal is not possible in the short run in facilities designed for other fuels.

The immediate opportunity to conserve fuels and energy is limited to more efficient use of lighting, etc. and savings in excess of 1% or 2% are not expected.

4.2 Task II, Quantification of the Major Substitutability and Conservation Opportunities

In shifting from petroleum based fuels to coal, savings of petroleum based fuels or gas can be achieved:

- About 4 barrels of oil for each ton of coal
- About 25 MCFT of natural gas for each ton of coal

The industry already supplies about 68% of its energy needs from coal, 13% from gas and 10% from oil. A limited opportunity exists for shifting back to coal from oil and gas.

4.3 Task III, Principal Constraints

The principal constraints on the possibility of shifting from petroleum-based fuels to coal for power generation are original facility design, time and costs.

- Facilities initially designed for coal and not stripped of coal handling capabilities can be converted back to coal burning in the near-term.

- In the long-term, essentially all oil or gas facilities can be substituted by coal burning, if this is environmentally acceptable. For the same output the capital costs of a coal burning unit can be five times those of an oil or gas facility, not including environmental controls.

- In certain states, strict environmental laws may apply a further constraint on the substitutability of coal for petroleum-based fuels.

4.4 Task IV, Plant Level Operating Characteristics

The production of cellulosic fibers is primarily dependent upon the supply of raw materials and on fuels to generate the power required for the primary reaction.

- The output of cellulosic fibers is directly proportional to the supply of raw materials.

- The output of cellulosic fibers is essentially directly proportional to the supply of fuel for power generation.

- Cellulosic fiber plants typically must be operated at over 80% of capacity to turn a profit.

4.5 Task V, Capital Stock (1973)

The 1973 gross book value of fixed assets was about $700 million. This estimate is based on the following:

- the 1972 Census of Manufactures indicates that the gross book value of fixed assets was $624 million in 1971 and in 1972 capital expenditures were $40 million

- it is assumed that 1973 capital expenditures were somewhat offset by the retirement of about 20 million lbs of capacity from the gross book value and that the net increase was $30 million.

The sixteen significant plants of this industry are 10 years or older. The estimated 1973 capital cost is from $1.00 to $1.50 per pound of production capacity. Present production capacity is about 1.5 billion lbs per year, reported by the Textile Economics Bureau. Then, the replacement value of present production capacity is $1.5 to $2 billion. Capital investment in recent years has been confined mainly to improvements of existing facilities.

4.6 Task VI, Planned Capital Investment (1974)

There appear to be no plans for major capital investment in the cellulosic fiber industry for 1974. Capital expenditures in the $10 million to $40 million range are expected.

4.7 Task VII, Changes to Investment Plans

The primary effect of potential coal substitution for gas or oil would be to increase capital investment.

5. INTRA-INDUSTRY EFFICIENCY

The findings in this section have been developed through analysis of industry and in-house data and with the assistance of a technical industry spokesman working with the Textile Economics Bureau.

5.1 Task I, Energy Efficiency

From Exhibit VI-6 it is seen that from 60,000 to 64,000 BTUs were required in 1971 per pound of SIC 2823 industry's product. In 1973 this was about 55,000 BTUs, accounting for a roughly 10% decrease in the unit energy requirement. The decrease occurred in rayon manufacture, where shifts from coal use to purchased electricity are significant. In 1973 acetate fiber production was roughly 15% more energy intensive per pound than rayon production.

The industry is highly concentrated and characterized by large plants, generally ten years or older. Sixteen major locations produce, on the average, 80 million lbs of fiber annually. There is probably appreciable variation of energy efficiency from plant to plant, not only by major fiber type as indicated above, but also by fiber specification.

5.2 Task II, Major Factors Affecting Efficiency

The major factor affecting energy efficiency is probably the age of the industry's production facilities. Heat utilization may not represent state-of-the-art as defined by engineering practice of recent years.

6. PRINCIPAL CONSTRAINTS ON CURRENT INDUSTRY OPERATIONS

The findings presented in this section have been obtained through the assistance of a technical industry spokesman and through the analysis of secondary sources and in-house information.

6.1 Task I, Important Constraints

It is seen in Exhibit VI-4 that the quantity of production of cellulosic fibers by the industry has remained essentially constant since 1967. This suggests that growing demand for cellulosic fibers is not a constraint on the industry's operations.

The principal raw materials of this industry are not petroleum derived. Acetic anhydride shortages can be a problem, but there was no strong evidence of this in 1973.

6.2 Task II, Most Serious Constraint

The petroleum allocation program could become a serious constraint if fuel availability is appreciably less than that corresponding to the requirements of production capacity.

6.3 Task III, 1974 Output, Prices and Employment

In 1973 industry production represented about 90 percent of effective capacity utilization. Demand outstripping capacity is not likely to be encountered in 1974.

A less than 5% decrease is expected in the output of rayon by the industry in 1974, while a less than 10% decrease is anticipated for acetate fibers. Historical demand trends as well as the indirect impacts of petroleum materials related shortages could account for this.

Price increases of about 10% are projected for 1974 under passthrough of raw material costs and profit control as of January 31, 1974.

Changes in the price of crude oil will not directly affect the price of the major raw materials of this industry, since these are not petroleum derived, with the exception of acetic anhydride.

It is seen from Exhibit VI-2-8 that employment in the industry decreased nearly 17% from 1971 to 1973, from 23,812 to 19,631. Information from industry sources is that employment will continue to decrease into 1974, but that these decreases will be the result of the normal attrition pattern in the industry.

6.4 Task IV, Outputs Critical to Subsequent Production

From data provided by the Textile Economics Bureau, the major end-uses of cellulosic fibers are listed below in order of product mix importance.

- broad woven goods: 43%.
- flat knit goods: 15%.
- non-woven goods: 12%.
- tires: 6%.

All of these end-uses are important in the economy.

EXHIBIT VI -1
FEO: USDC
DEFINITION OF SIC 2823[1]

SIC 2823 CELLULOSIC MAN-MADE FIBERS

Establishments primarily engaged in manufacturing cellulosic fibers (including cellulose acetate and regenerated cellulose such as rayon by the viscose or cuprammonium process) in the form of monofilament, yarn, staple or tow suitable for further manufacturing on spindles, looms, knitting machines or other textile processing equipment. Establishments primarily engaged in manufacturing textile glass fibers are classified in Industry 3229.

Acetate fibers
Cellulose acetate monofilament, yarn, staple, or tow
Cellulose fibers, man-made
Cigarette tow, cellulosic fiber
Cuprammonium fibers
Fibers, cellulose man-made
Fibers, rayon
Horsehair, articicficial: rayon
Nitrocellulose fibers
Rayon primary products: fibers, straw, strips, and yarn
Rayon yar, made in chemical plants (primary products)
Regenerated cellulose fibers
Triacetate fibers
Viscose fibers, bands, strips, and yarn
Yarn, cellulosic: made in chemical plants (primary products)

Source: 1972 Standard Industrial Classification Manual

(1) The 1972 SIC definition is the same as that used in the 1967 census.

EXHIBIT VI-2-1
FEO:USDC
REQUIRED TABLE 1

Proportion of Industry Output Accounted for by Each Major Process, 1973

SIC 2823 Industry Cellulosic Manmade Fibers

Process and Major Products	Percent of 1973 Shipments Value	Percent of 1973 Production Volume 1/
Rayon fibers	53.2%	64.8%
Acetate fibers	45.1	33.5
Secondary products and miscellaneous receipts	1.7	1.7
Total Industry (Percent)	100.0	100.0
(Actual)	$707,100,000	1,242,800,000

1/ Production volume expressed in pounds.

Source: Exhibits VI-3 and VI-4.

EXHIBIT VI - 2-2a
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume, 1971 and 1973 (1)

SIC 2823 Industry Cellulosic Fibers

Process Rayon

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures	1,000 barrels	72.2			72.2	885.04			885.04
2	Middle distillates	1,000 barrels	342.9			342.9	206.63			206.63
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	1,000 Short tons	1,729.5			1,729.5	1,058.9			1,058.9
8	Natural gas	Billion Cu. Ft.	1,912			1,912	3,711			3,711
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	Million KWH	102.03			102.03	238.4			238.4
12	GRAND TOTAL									

Source: (1) Derived from Exhibit VI-5 and corresponding to the production figures of Exhibit VI-4.

EXHIBIT VI - 2-3a
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billion BTUs, 1971

SIC 2823 Industry Cellulosic Fibers

Process Rayon

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	Billion BTUs	400			400	5,200			5,200
3	Residual fuel oil	Billion BTUs	2,200			2,200	1,300			1,300
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	Billion BTUs	45,300			45,300	27,700			27,700
8	Natural gas	Billion BTUs	2,000			2,000	3,800			3,800
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	Billion BTUs	1,100			1,100	2,500			2,500
12	GRAND TOTAL					51,000				40,500

EXHIBIT VI - 2-4a
FEO: USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH equivalents, 1971 and 1973

SIC 2823 Industry Cellulosic Fibers

Process Rayon

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	Million KWH	100			100	1,500			1,500
3	Residual fuel oil	Million KWH	600			600	400			400
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	Million KWH	13,300			13,300	8,100			8,100
8	Natural gas	Million KWH	600			600	1,100			1,100
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased) (1)	Million KWH	300			300	700			700
12	GRAND TOTAL					14,900				11,800

(1) Electricity times 3.1 to express as fuel equivalents.

EXHIBIT VI - 2-2b
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume, 1971 and 1973 (1)

SIC 2823 Industry Cellulosic Fibers

Process Acetate

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	1,000 barrels	64.4			64.4	29.3			29.3
3	Residual fuel oil	1,000 barrels	81.8			81.8	168.4			168.4
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	1,000 short tons	817.7			817.7	667.8			667.8
8	Natural gas	Billion Cu. Ft.	4.139			4.139	4.470			4.470
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	Million KWH	206.82			206.82	261.9			261.9
12	GRAND TOTAL									

Source: (1) Derived from Exhibit VI-5 and corresponding to the production figures of Exhibit VI-4.

EXHIBIT VI - 2-3b
PRO-USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billion BTUs, 1971 and 1973

SIC 2823 Industry Cellulosic Fibers

Process Acetate

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	Billion BTU s	400			400	200			200
3	Residual fuel oil	Billion BTU s	500			500	1,100			1,100
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	Billion BTU s	21,400			21,400	17,500			17,500
8	Natural gas	Billion BTU s	4,300			4,300	4,600			4,600
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	Billion BTU s	2,200			2,200	2,800			2,800
12	GRAND TOTAL					28,800				26,200

EXHIBIT VI - 2-4b
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Million KWH Equivalents, 1971 and 1973

SIC 2823 Industry Cellulosic Fibers

Process Acetate

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	Million KWH	100			100	100			100
3	Residual fuel oil	Million KWH	200			200	300			300
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	Million KWH	6,300			6,300	5,100			5,100
8	Natural gas	Million KWH	1,300			1,300	1,400			1,400
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased) (1)	Million KWH	600			600	800			800
12	GRAND TOTAL	Million KWH				8,500				7,700

(1) Electricity times 3.1 to express as fuel equivalents.

EXHIBIT VI-2-5
FEO: USDC
REQUIRED TABLE 5

Industry Consumption of Fuels, Petroleum Products, and Energy by Type - 1971, 1973, and 1974

SIC 2823 Industry Cellulosic Fibers

Line No.	Type of Energy or Material	Unit of Measure	Volume (2) (1) 1971	Volume (2) 1973	Volume (2) (2) 1974	Bil. BTU-s* 1971	Bil. BTU-s* 1973	Bil. BTU-s* 1974	% Change 1971-73	% Change 1973-74	% of Total BTU s 1971	% of Total BTU s 1974
1	Propane, butane, and mixtures											
2	Middle distillates	1,000 barrels	136.9	931.7	899.5	800	5,430	5,250	581	(3.4)	1.0	3.0
3	Residual fuel oil	1,000 barrels	166.9	382.1	369.9	1,050	2,400	2,320	129	(3.4)	1.3	3.5
4	Chemical feedstocks											
5	Other petroleum, products, total											
6	Petroleum products, total											
7	Coal	1,000 short tons	2,440.4	1,759.5	1,700.6	63,940	46,100	44,540	(28)	(3.4)	78.9	67.9
8	Natural gas	billions cu. ft.	11.6	8.34	4.86	11,970	8,600	4,920	(28)	(3.4)	14.8	12.7
9	Fuels, n.e.c. total											
10	Other fuels, total											
11	Electrical energy (purchased only) (2)	millions KWH	334.7	510.9	493.6	3,550	5,400	5,220	53	(3.4)	4.0	7.9
12	GRAND TOTAL		(X)	(X)	(X)	81,310	67,940	65,640	(16.4)	(3.4)	100%	100%

Source: (1) Based on census "Fuels and Electric Energy Consumed," MC 72 (SR)-6, except for purchased electrical energy (see footnote (2)).
(2) Energy factors in Exhibit IV-7 multiplied by total production on Line 1, Exhibit VI-4. For 1974 the 1973 energy factors were applied to the average expected production in 1974.

* BTU s and Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

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EXHIBIT VI-2-5a
FEO:USDC
REQUIRED TABLE 6

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit

SIC 2823 Industry Cellulosic Fibers Year 1971

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
1	United States		136.9	166.9			1,850	2,440.6	11.6		75,900	3,550	31,300
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.												
8	R.I.												
9	Conn.												
10	Middle Atlantic												
11	N.Y.												
12	N.J.												
13	Penn.		9	11		-	120	150	0.8		4,800	200	5,100
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio												
17	Ind.												
18	Ill.												
19	Mich.												
20	Wisc.												
21	W. North Central												
22	Minn.												
23	Iowa												
24	Mis.												
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.
(1) The geographic fuels and energy BTUs from VI-2-8 were distributed by type according to the national distribution of these in Exhibit VI-2-5.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Petroleum Products: Distillates (Thousand Barrels)	Petroleum Products: Residual (Thousand Barrels)	Petroleum Products: Feedstocks (Thousand Barrels)	Petroleum Products: Other (Thousand Barrels)	Petroleum Products: Total (Bil. BTU's)*	Other Fuels: Coal (Thousand Short Tons)	Other Fuels: Natural Gas (Bil. Cu. Ft.)*	Other Fuels: Fuels, n.e.c. (Bil. BTU's)*	Other Fuels: Total (Bil. BTU's)*	Purchased Electrical Energy (Bil. BTU's)*	Grand Total (Bil. BTU's)*
29	SOUTH		130	160			1,790	2,250	11.3		70,600	3,100	76,000
30	S. Atlantic		90	110			1,190	1,500	7.5		47,100	2,100	50,700
31	Del.		9	11			120	150	0.8		4,800	200	5,100
32	Md.												
33	D.C.		36	43			490	600	3.0		19,200	800	20,300
34	Va.		20	21			250	300	1.5		9,600	400	10,200
35	W. Va.		9	11			120	150	0.8		4,800	200	5,100
36	N.C.		9	11			120	150	0.8		4,800	200	5,100
37	S. C.		9	11			120	150	0.8		4,800	200	5,100
38	Ga.												
39	Fla.												
40	S. Central		45	53			600	750	3.8		24,000	1,000	25,600
41	Ky		36	42			400	600	3.0		19,200	800	20,300
42	Tenn.		9	11			120	150	0.8		4,800	200	5,100
43	Ala.												
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas												
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU's & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

NOTE: States for which SIC 2823 is not applicable or for which data is not available are shown in Exhibit VI-2-8.

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit

SIC 2823 Industry Cellulosic Fibers Year 1973

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
1	United States		932	900			7,800	1,800	8.3		54,700	5,400	67,900
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.												
8	R.I.												
9	Conn.												
10	Middle Atlantic												
11	N.Y.												
12	N.J.												
13	Penn.		58	56			500	100	0.5		3,400	300	4,200
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio												
17	Ind.												
18	Ill.												
19	Mich.												
20	Wisc.												
21	W. North Central												
22	Minn.												
23	Iowa												
24	Mis.												
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

(1) The geographic fuels and energy BTUs from Exhibit VI-2-8 were distributed by type according to the national distribution of these in Exhibit VI-2-5.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU's)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU's)*	Total (Bil. BTU's)*	Purchased Electrical Energy (Bil. BTU's)*	Grand Total (Bil. BTU's)*
29	SOUTH		875	845			7,300	1,700	7.8		51,300	5,100	63,700
30	S. Atlantic		580	560			5,000	1,000	5.0		34,000	3,000	42,000
31	Del.												
32	Md.		58	56			500	100	0.5		3,400	300	4,200
33	D.C.												
34	Va.		240	220			2,000	400	2.0		14,600	1,200	16,800
35	W. Va.		120	110			1,000	200	1.0		7,300	600	8,400
36	N.C.		58	56			500	100	0.5		3,400	300	4,200
37	S. C.		58	56			500	100	0.5		3,400	300	4,200
38	Ga.		58	56			500	100	0.5		3,400	300	4,200
39	Fla.												
40	S. Central		300	280			2,500	500	2.5		18,000	1,500	21,000
41	Ky												
42	Tenn.		240	220			2,000	400	2.0		14,600	1,200	16,800
43	Ala.		58	56			500	100	0.5		3,400	300	4,200
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas												
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU's & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

NOTE: States for which SIC 2823 is not applicable or for which data is not available are shown in Exhibit VI-2-8.

Shipments, Employment, and Fuels and Energy Consumed by Geographic Unit, 1971 and 1973

SIC 2823 Industry Cellulosic Manmade Fibers

Line Number	Geographic Unit	Value of Shipments (4) ($ Millions)			Employment			Fuels and Energy (4) (Bil. BTU s) *		
		1971	1973 (6)	% Change	1971	1973	% Change (3)	1971	1973 (6)	% Change
1	United States	662	707	6.8	23,182 (1,3)	19,631 (2,3)	(17.6)	81,300	67,900	(16.5)
2	NORTH EAST	(NA) (5)								
3	New England									
4	Maine									
5	N.H.									
6	Vermont									
7	Mass.									
8	R.I.									
9	Conn.									
10	Middle Atlantic	(NA)								
11	N.Y.	(NA)								
12	N.J.									
13	Penn.	41	44		1,500	1,200		5,100	4,200	
14	NORTH CENTRAL	(NA)								
15	E. North Central	(NA)								
16	Ohio	(NA)								
17	Ind.									
18	Ill.									
19	Mich.									
20	Wisc.									
21	W. North Central									
22	Minn.									
23	Iowa									
24	Mis.									
25	N.D.									
26	S.D.									
27	Neb.									
28	Kans.									

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Table 8 Continuation

Line Number	Geographic Unit	Value of Shipments ($ Millions) 1971	1973 (6)	% Change	Employment 1971	1973	% Change	Fuels and Energy (Bil. BTU's) * 1971	1973 (6)	% Change
29	SOUTH	621	662		22,300	18,400		76,300	62,800	
30	S. Atlantic	414	441		14,900	12,300		50,900	41,800	
31	Del.									
32	Md.	41	44		1,500	1,200		5,100	4,200	
33	D.C.									
34	Va.	165	177		6,000	4,900		20,300	16,800	
35	W. Va.	83	88		3,000	2,500		10,200	8,400	
36	N.C.	41	44		1,500	1,200		5,100	4,200	
37	S.C.	41	44		1,500	1,200		5,100	4,200	
38	Ga.	41	44		1,500	1,200		5,100	4,200	
39	Fla.									
40	S. Central	207	221		7,400	6,100		25,400	21,000	
41	Ky.									
42	Tenn.	165	177		6,000	4,900		20,300	16,800	
43	Ala.	41	44		1,500	1,200		5,100	4,200	
44	Miss.									
45	Ark.									
46	La.									
47	Okla.									
48	Texas									
49	WEST									
50	Mountain									
51	Mont.									
52	Idaho									
53	Wyo.									
54	Colo.									
55	N.M.									
56	Ariz.									
57	Utah									
58	Nev.									

* BTU's & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Table 8 - Continuation

Line Number	Geographic Unit	Value of Shipments ($ Millions)			Employment			Fuels and Energy (Bil. BTU s)		
		1971	1973 (6)	% Change	1971	1973	% Change	1971	1973 (6)	% Change
59	Pacific									
60	Wash.									
61	Ore.									
62	Cal.									
63	Alas.									
64	Haw.									

Source:

(1) From County Business Patterns, 1971.

(2) From Exhibit VI-7.

(3) State employment levels estimated by Snell, as shown in Exhibit VI-8. According to this convention "% Change" is the same for each state as at the national level.

(4) Distribution was estimated according to the employment pattern. U. S. value of shipments are from Exhibit VI-3 and U. S. fuels and energy are from Exhibit VI-2-5.

(5) The designation "(NA)" means unquantified employment reported by County Business Patterns for 1971 and 1972 but no major plant is reported by the Textile Economics Bureau.

(6) 1973 figures have been calculated using percent change from 1971 at the national level.

EXHIBIT VI-2-9 and VII-2-9
FEO: USDC
REQUIRED TABLE 9

Stocks of Fuels and Petroleum Products by Type, 12/31/73 and 3/31/74

SIC 2823 and 2824 Industry Man-Made Fibers, Cellulosic and Noncellulosic

Line Number	Type of Energy or Material	Stocks (# of days supply related to average daily requirements in next quarter) (1)					
		As of December 31			As of March 31		
		1971	1972	1973	1972	1973	1974
1	Propane						
2	Butane						
3	Propane Butane Mixture						
4	Middle Distillates(2)	17	16	38	15	15	30
5	Residual Fuel Oil(3)	23	15	31	18	16	21
6	Chemical Feedstocks						
7	Other Petroleum Products, total						
8	Coal(4)	39	37	40	43	40	43
9	Natural Gas						
10	Fuels, n.e.c., total						

(1) Source: Textile Economics Bureau.
(2) 8 companies.
(3) 10 companies.
(4) 6 companies.

EXHIBIT VI-3

FEO:USDC

SIC 2823 - VALUE OF SHIPMENTS—1967, 1971-1974

(Dollars in Millions)

Line	Item	1967	1971	1972	1973	1974 (6) Low	1974 (6) High
1.	Value of all products and services sold by SIC 2823 industry (1)	$902.8	$662.4	$627.1	$707.1	$721	$778
2.	Value of SIC 2823 products shipped by SIC 2823 industry (2)	613.0	612.1	616.1	694.7	709	765
3.	Value of SIC 2823 products shipped by all industries (3)	681.1	680.1	684.6	771.9	787	849
4.	Ratio of SIC 2823 products shipped by SIC 2823 industry to those shipped by all industries (coverage ratio) (4)	0.90	0.90	0.90	0.90	0.90	0.90
5.	Value of major SIC 2823 products shipped by SIC 2823 industry: (5)						
	Rayon fibers	$306.9	$320.5	$349.7	$375.9	$393	$414
	Acetate fibers	306.1	291.6	266.4	318.8	316	351

Footnotes:

(1) Figures for 1967, 1971, and 1972 obtained from Sources (a), (b), and (c). Figures for 1973 and 1974 obtained from value in line 2 using same ratio as for 1972.

(2) Figures from 1967, 1971, and 1972 obtained from values in line 3 using ratio given in line 4. Figures for 1973 and 1974 are sums of figures in individual product categories.

(3) Figures for 1967, 1971, and 1972 obtained from Sources (a), (d), and (c). Figures for 1973 and 1974 obtained from values in line 2 using ratio given in line 4.

(4) Ratio estimated from value of secondary products of SIC 2824 industry based upon facts and figures that show most of SIC 2823 products shipped by industries other than SIC 2823 industry come as secondary products from SIC 2824 industry.

(5) Figures for 1967, 1971 and 1972 obtained from Sources (a), (d), and (c) modified by ratio given in line 4. Figures for 1973 obtained from 1972 figures by applying the ratio of volumes shipped in these two years, (Source (e)), and applying a 10% increase in price.

(6) Figures for 1974 built up from individual product category figures which are estimated to range from a minimum of 5% and 10% declines from 1972 shipments for, respectively, rayon and acetate fibers to a maximum of zero growth. In all cases, a 10% price increase is assumed.

Sources:

(a) "Industry Statistics," 1967 Census of Manufactures, U.S. Department of Commerce, Volume II, Part 2, Major Groups 25-33, 1971, pp. 28B1-25.

(b) "General Statistics for Industry Groups and Industries," Annual Survey of Manufactures-1971, U.S. Department of Commerce, Publication M71 (AS)-1, April 1973.

(c) "Cellulosic Manmade Fibers, SIC 2823," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC 72(P) 28B-3, December 1973.

(d) "Value of Product Shipments," Annual Survey of Manufactures - 1971, U.S. Department of Commerce, Publication M 71 (AS)-2, October 1973.

(e) Textile Organon, Volume XLV, No. 1-2, January-February 1974.

FEO:USDC

SIC 2823 - PRODUCTION VOLUME--1967, 1971-1974

(Pounds in Millions)

Line	Item	1967	1971	1972	1973	1974(6) Low	1974(6) High
1.	Total production by SIC 2823 industry(1)	1,839.9	1,354.7	1,277.2	1,242.8	1,160	1,243
2.	Total production of SIC 2823 products by SIC 2823 industry(2)	1,249.3	1,251.1	1,254.9	1,221.1	1,139	1,221
3.	Total production of SIC 2823 products by all industries(3)	1,388.1	1,390.1	1,394.3	1,356.8	1,266	1,357
4.	Ratio of production of SIC 2823 products by SIC 2823 industry to total production of SIC 2823 products by all industries(4)	0.90	0.90	0.90	0.90	0.90	0.90
5.	Production of major SIC 2823 products by SIC 2823 industry: (5)						
	Rayon fibers	821.3	823.1	868.5	805.1	765	805
	Acetate fibers	428.0	428.0	386.4	416.0	374	416

Footnotes:

(1) Figures are stated in "equivalent" pounds of SIC 2823 materials calculated from figures in line 2 by applying the ratio of the total value of SIC 2823 products and services sold by SIC 2823 industry to the value of SIC 2823 products shipped by the industry (see Exhibit VI-3).

(2) Figures calculated from value in line 3 using ratio given in line 4.

(3) Figures for 1967 and 1971-1973 obtained from Source (a).

(4) Ratio is that which was established for the value of shipments for this industry (see Exhibit VI-3)

(5) Figures for 1967 and 1971-1973 calculated from total production of these products by all industries by applying the ratio given in line 4.

(6) Figures for 1974 built up from quantities estimated for individual product categories which are estimated to range from a minimum of 5% and 10% declines for, respectively, rayon, and acetate production to a maximum of zero growth (Source (b)).

Sources:

(a) Textile Organon, Volume XLV, No. 1-2, January-February 1974.

(b) Personal interview with Mr. Charles Whitehead, Textile Economics Bureau, New York, March 1, 1974.

(c) "Industry Statistics," 1967 Census of Manufactures, Vol. II, Part 2, Major Groups 25-33, U.S. Department of Commerce, 1971, pp. 28B1-25.

(d) "Cellulosic Manmade Fibers, SIC 2823," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC 72(P)-28B-3, December 1973.

EXHIBIT VI-5 and VII-5
FEO: USDC
ENERGY CONSUMPTION IN FIBER PRODUCTION [1]

Product and Year	Reporters[2] Percent of Total Production	Energy Consumed[6] Per Lb. Product BTUs/Lb. (000)	Coal-Tons	#2 Oil[6] (000 Barrel)	#6 Oil[6] (000 Barrel)	Natural Gas (000 Cu. Ft.)	Purchased Electricity (000 KWH)	Percent of Electricity Purchased
Rayon - 1971	76	61.9	1,460,480	60.98	289.86	1,615,520	86,163	5%
- 1973	97	50.4	1,141,310	953.88	222.71	3,999,607	256,995	12%
Acetate - 1971	142[3]	67.2	1,290,121	101.57	129.12	6,529,701	326,321	32%
- 1973	144[3]	63.0	1,068,442	46.95	269.36	7,151,400	419,100	30%
Polyester - 1971	62	19.9	233,650	62.79	334.64	5,897,269	729,464	57%
- 1973	94	17.3	239,638	150.52	1,423.14	8,728,905	2,039,675	67%
Nylon 66 - 1971	(4)		225,733	12.64	1,147.45	3,386,413	796,185	71%
- 1973	(4)	25.0[7]	180,478	53.33	1,687.14	3,071,668	1,161,446	79%
		20.6[7]						
Nylon 6 - 1971	(4)		59,974	20.36	157.71	484,589	235,202	77%
- 1973	(4)		96,534	77.95	421.12	1,043,134	527,575	96%
Acrylic+ Modacryl.- 1971	100	47.1[5]	572,108	85.40	387.12	3,824,619	357,464	87%
- 1973	100	43.4[5]	534,042	27.88	3,847.62	1,924,106	422,894	88%
Olefin - 1971	51	24.6	13,689	11.55	4.76	1,208,966	218,834	91%
- 1973	48	19.0	6,751	22.02	13.86	1,277,859	260,221	93%

(1) Source: Textile Economics Bureau.
(2) With respect to figures compiled by the Textile Economics Bureau for the industry and published in Textile Organon, January-February 1974. SIC 2823 industry production of rayon and acetate covers about 90% of the total production of these fibers. SIC 2824 industry production of non-cellulosic fibers covers about 98% of the total production of these fibers. Dividing the fuel and energy quantities by the "% Reporting", and multiplying by the appropriate coverage ratio provides annual total figures for the appropriate fibers in each SIC.
(3) Total is more than 100% due to inclusion of cigarette tow and flake.
(4) Nylon 6+66 coverage was 77% for 1971 and 97% for 1973. Nylon 66 represents more than 2/3 of the total nylon output.
(5) These numbers are heavily weighted towards acrylic, 1973 shipments of which were more than 10 times those of modacrylic. Separate modacrylic cannot be shown because of disclosure.
(6) Snell estimates based on Textile Economics Bureau data.
(7) The top figure is for both nylons for 1971 and the bottom figure is for 1973.

EXHIBIT VI-6
FEO: USDC
SIC 2823-PRODUCT MIX--1967, 1971 TO 1973

Line	Item	1967	1971	1972	1973
		Million Lbs.			
1	Total Production by SIC 2823 Industry	1,840	1,355	1,277	1,243
		Percent of Total Production by Weight			
2	Rayon	44.6%	60.8%	68.0%	64.8%
3	Acetate	23.3	31.6	30.3	33.5
4	Other (1)	32.1	7.6	1.7	1.7

Source: Snell estimates based on data in Exhibit VI-4.
(1) "Other" category represents equivalent production of secondary products and services estimated based on value of shipment figures (Exhibit VI-3). The rather high percentages of "other" production in 1967 and, to a lesser extent, in 1971 are a direct result of commerce data for these years.

EXHIBIT VI-7

FEO: USDC

SIC 2823 - ENERGY FACTORS 1967, 1971, AND 1973

(Per Million Pounds Produced)

Line	Item	Units	Year 1967[1]	1971-A[1]	1971-B[2]	1973[2]
1	Production[1]	Million pounds	1,840	1,355		1,243
2	BTUs equivalent of fuels		(NA)	57.38	61.11	50.32
3	Coal	1,000 short tons	1.793	1.801	2.036	1.416
4	Distillates	1,000 barrels	(NA)	0.101	0.109	0.749
5	Residual	1,000 barrels	(NA)	0.123	0.339	0.308
6	Natural gas	Billion cu. ft.	0.00527	0.00856	0.00484	0.00405
7	Other fuels	-	-	(Z)		-
8	Fuels nsk.	-	-	(Z)		-
9	Electricity purchased	Million KWH	0.256	0.247[2]	0.247	0.411
10	BTUs equivalent of purchased electricity	Billion BTUs	2.72	2.62	2.62	4.36
11	Electricity generated					
12	BTUs equivalent of fuels and purchased electricity	Billion BTUs	(NA)	60.00	63.73	54.68

(1) Census data (except for 1971-A purchased electricity) from "Fuels and Electric Energy Consumed," MC67(S)-4 and MC72(SR)-6 divided by total production from Line 1 of Exhibit IV-4.

(2) Based on the data for rayon and acetate in Exhibit VI-5, provided by the Textile Economics Bureau.

EXHIBIT VI-8
FEO: USDC
EMPLOYMENT IN THE FIBERS INDUSTRY

	Total Employees			
	A	B	C	D
Year	SIC 2823 and 2824 After BLS [1]	SIC 2823 and 2824 After CBP [2]	SIC 2823	SIC 2824
1971	109,200	92,067 [2]	23,812 [2]	68,922 [2]
1972	114,600	92,616 [2, 3]	22,461 [2]	70,155 [2]
1973	122,300	99,063 [4]	19,631 [5]	79,432

(1) Private communication between Snell and the Bureau of Labor Statistics (BLS).
(2) County Business Patterns (CBP), 1971 and 1972.
(3) The ratio of B to A for 1972 is 0.81. Assume that this ratio holds for 1973.
(4) Total employees for fibers industry, A, for 1973 multiplied by 0.81 from (3) above.
(5) Based on a 1.26% decrease in capacity from 1972 to 1973 of rayon and acetate plants, after "Textile Organon," Vol. XLIV, No. 12, December 1973.

EXHIBIT VI-9

FEO: USDC

SIC 2823 - RAYON AND ACETATE PLANT AND EMPLOYMENT DISTRIBUTION BY STATE--1971 AND 1973

States	1971 and 1973 Total Number of Plants (1)	Estimated Number of Employees Per State (3) 1971	1973
Maryland	1	1,488	1,227
Pennsylvania	1	1,488	1,227
North Carolina	1	1,488	1,227
South Carolina	1	1,488	1,227
Virginia	4	5,952	4,908
West Virginia	2	2,976	2,454
Alabama	1	1,488	1,227
Georgia	1	1,488	1,227
Tennessee	4	5,952	4,908
A. Total Number of Plants	16		
B. Number of Employees (2)		23,812	19,631
C. Average Number of Employees Per Plant		1,488	1,227

(1) "Textile Organon," Vol. XLIV. No. 9, September 1973.
(2) From Exhibit VI-8, Column C.
(3) Estimates based on the fact that the plants are large and on the assumption that capacities are roughly the same.

SECTION VII

SIC 2824, ORGANIC FIBERS, NONCELLULOSIC

Exhibit VII-1 at the end of this section presents a detailed industry definition. In 1971 value added by manufacture was $1,905 million according to the Annual Survey of Manufactures, while value of shipments was $3,241 million and total gross book value of depreciable assets was $3,839 million. The same source reports energy consumption of 38.6 billion KWH equivalents. County Business Patterns, 1972, reports that about 70 establishments were classified in SIC 2824.

The most important findings follow regarding the economic impact shortages during 1973 and the first quarter of 1974:

- Fuel shortages were of concern but did not cause serious disruptions.
- Raw material shortages were claimed with acrylonitrile and nylon intermediates in particularly short supply.
- Employment was not significantly affected, and during 1974 increases proportionate to production capacity changes were projected.
- No major near-term opportunities for substitution or conservation of fuels were identified.
- There are no significant differences in the energy efficiency of major processes with the exception of the more energy intensive acrylic fibers.

Exhibit VII-2, following Exhibit VII-1, features the Required Tables. These tables and supporting exhibits further define the industry's structure both in economic and energy terms.

All exhibits appear sequentially at the end of this section. Whenever electricity KWHs are expressed as BTUs, conversion is based on the nom-nominal fuel requirements to generate the electricity.

1. MAJOR USES OF FUELS, ENERGY AND PETROLEUM PRODUCTS

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

1.1 Task I, Major Processes

There are three major processes in this industry, the manufacture of nylon, polyester and acrylic fibers, respectively.

1.1.1 Nylon Production

There are several types of nylon, the two most important are Nylon 6 and Nylon 6,6.

Nylon 6 is produced by the continuous polymerization of caprolactam. Molten caprolactam is mixed with water, catalysts, stabilizer and delusterant and is fed into a reactor which is operated at about 500°F. The overall reaction is slightly exothermic and heat exchange is provided by dowtherm.

There are two methods being used to purify the crude polymer and recover unreacted polymer. In the first, the polymer is cast into ribbon form, quenched and cut into chips. The chips are dried and are then ready for melting and spinning.

In the second method, the molten polymer exiting from the reactor is sent to a vacuum distillation column where monomer, water and oligomers are removed overhead. The molten polymer can then be spun directly into fibers.

Nylon 6,6 is made by polymerization of nylon salt (hexamethylene diammonium adipate) from an aqueous suspension at elevated temperature and pressure. Two processes are in general use, batch and continuous. Nylon salt is usually stored as a 40-50% aqueous solution and can easily be made from aqueous solutions of adipic acid and hexamethylene diamine.

Nylon salt solution is fed to a think film evaporator at about 230^{o}F. Additives are introduced and these plus the dewatered monomer are fed to another thin film evaporator held at 450^{o}F. and elevated pressure where the condensation polymerization takes place. Molten polymer goes to a "flasher" at atmospheric pressure. The polymer may be put through a finishing step at 540^{o}F. The hot molten polymer goes directly to spinning, drawing and beaming operations. A great portion of polymerization is batch-wise.

The molten nylon is forced with high pressure through a sandpacked filter. Then, the nylon is extruded through a spinneret into the open air where it is immediately cooled. The filaments are drawn away from the spinneret and united into a single thread. The yarn then is bathed in steam and passed over a finish roll which applies a material that cements the filaments into a thread. The yarn passes over rolls which give it power for drawing away from the spinneret. After this, it is wound on a bobbin and the first stage of the yarn manufacture has been completed.

In many operations flake is produced from the polymer and remelted at the spinning machine.

Unoriented yarn is still not a textile fiber but can readily be made so by converting it from a plastic condition to an elongated condition. This is done by stretching it in a rewind operation. It is also done by a stretching coupled to spinning process.

Similar processes may be used for extruding nylon into coarser monofilaments for use as bristles and for other applications.

1.1.2 Polyester Fiber Manufacture

There are two basic steps in the process. The production of the polymer and the thread forming itself.

There are two basic production systems. In one system the polymerization is carried out batch-wise and the polymer is stored as chips which are remelted before thread forming. Continuous integrated processes start with monomer glycol and catalysts. The monomer is fed with the appropriate amount of glycol and catalysts to an esterification column in which the first polymerization steps take place through esterification or ester exchange. The mixture then goes to the low polymerizer from which excess glycol is removed under vacuum, then to the high polymerizer where polymerization is completed and hence directly to the spinning system. Coupled spinning and drawing is also used in the industry.

Filaments are formed by forcing the molten polymer at about 290°C. through a sand-bed filter to a stainless steel spinneret containing many cylindrical holes of 9/1000 inch in diameter. The extruded filaments are cooled by a controlled air quench system. The filaments are joined to form a threadline. Several threadlines are converged, passed through on spin-finish applicators and wound together in a can or drawn and wound on bobbin and stretched.

The product can then be made into staple or continuous filament yarns by conventional processes.

1.1.3 Acrylic Fiber Production

Acrylonitrile is the chief raw material for the acrylic fibers. In the manufacture of acrylic fibers the main steps are: polymerizing the acrylonitrile, dissolving the polymer, spinning and after-treating.

The preferrred methods of polymerization are solution or dispersion in aqueous media. An activator and a catalyst are used to stimuate the polymerization. To improve the dyeability of the fiber, to produce more workable spinning solutions, acrylonitrile is copolymerized with other monomers.

The polymer is insoluble in the aqueous medium and is separated from it by centrifuging. It is then dried, ground, and stored, ready to be dissolved in a suitable solvent to form the spinning dope. Unreacted monomer in the aqueous filtrate may be recycled.

There are two spinning methods: wet spinning and dry spinning. In wet spinning, the spinning dope is forced by metering pumps through spinnerets. As the dope leaves the holes it enters a spin bath where the solvent diffuses from the filaments and the fiber coagulates.

In subsequent steps, the fiber is washed free of solvent, stretched and dried to remove water and to collapse the gel structure into a continuous phase.

In dry spinning, the acrylic fiber is spun from a solvent of high boiling point. The solvent is removed by hot air evaporation downstream from the spinneret and the process is similar to that for acetate fibers.

The acrylic and modacrylic fibers must be stretched to develop the desirable fiber properties.

Finishing of the fibers is accomplished by application of an antistatic agent, a softener and a lubricating agent.

The fibers can be processed by conventional means in Tow, Staple or Yarns.

1.2 Task II, Industry Output

Exhibit VII-3 presents value of shipments for 1967 and 1971 through 1974 projected. In 1973 the value of all products and services sold by SIC 2824 industry was $4,855 billion. Exhibit VII-4 indicates that this corresponded to 6,917 million lbs of production. Exhibit VII-2-1 summarizes the 1973 shipments value and production information of Required Table 1.

1.3 Task III, Energy Related Profile of Major Processes

Exhibit VII-5 summarizes the results of a survey by The Textile Economics Bureau of fuel and electricity use by the man-made fiber industry. The table below summarizes unit BTU requirements for the principal non-cellulosic fibers on the basis of these data.

Energy Consumed Per Lb Product, BTUs

Fiber	1971	1973
Polyester	19,900	17,300
Nylon (6,6 & 6)	25,000	20,600
Acrylic and Modacrylic	47,100	43,400
Olefin	24,600	19,000

Acrylic fibers are most energy intensive, while polyester fibers require the least heat and power input. Using the data of Exhibit VII-5, Required Tables 2, 3 and 4 were prepared for the fibers listed above. These appear in Exhibits VII-2-2, 3 and 4, series "a" through "e".

The overall energy consumption of the industry was 126,000 billion BTUs in 1971 and 152,000 billion BTUs in 1973 for an increase of 21%, according to the industry survey. This is estimated by summing the BTU requirements of each major process from Exhibit VII-2-2 "a" through "e" and adjusting upward by the ratio of Line 1 and Line 2 in Exhibit VII-4. The average overall unit energy consumption of the industry was 25,600 BTU per equivalent pound of product in 1971. In 1973 this was 21,900 BTU.

1.4 Task IV, Shifts In The Energy Related Profile Of The Industry - 1971 to 1973

The industry survey data discussed above indicates lower average energy requirements per pound of product for the industry than estimated using census figures for the fuel terms. Exhibit VII-6 presents energy factors derived from census data on fuels and the industry survey data on purchased electricity. In 1971 the energy consumption was 34,400 BTU per lb and 31,800 BTU per lb in 1973, or 34% higher in 1971 and 57% higher in 1973 than the survey based figures.

The census based energy factors were used in preparing the industry's energy profile, Required Table 5, shown in Exhibit VII-2-5. In 1971 SIC 2824 industry required about 170,000 billion BTUs of fuels and purchased electricity. In 1973 this was 220,000 billion BTUs for an increase of 30%.

The table below shows a comparison of fuels use (excluding purchased electricity) in 1971 according to census versus according to the industry survey.

1971 Fuels Use

	Percent of Fuel BTUs	
Item	Census	Industry Survey
Fuel Oils	21%	24%
Coal	46%	47%
Natural Gas	33%	29%
Total Fuel BTUs	129,500 Billion BTUs	85,800 Billion BTUs

Fuel configuration according to the two sources is reasonably close, particularly for coal, but a significant discrepancy exists in the total fuel BTUs. This suggests a need for study and comparison of the detailed data and assumptions in the two surveys.

1.5 Task V, Projected 1974 Energy Related Profile Of The Industry

Exhibit VII-2-5 also presents the projected energy profile of SIC 2824 for 1974. The profile was developed assuming the same energy factor for 1974 as for 1973, shown in Exhibit VII-6, because product mix and energy efficiency changes between the two years are not expected to be substantial. The factor was applied to the average "High" and "Low" production of 1974, shown in Exhibit VII-4. The 1973 energy factor assumes no significant change in the energy required per unit of production from 1973 to 1974 and an 8% increase in energy requirements over 1973 is projected.

The table following presents expected major raw material requirements in 1974, based on the average production.

1.4 Task IV, Shifts In The Energy Related Profile Of The Industry - 1971 to 1973

The industry survey data discussed above indicates lower average energy requirements per pound of product for the industry than estimated using census figures for the fuel terms. Exhibit VII-6 presents energy factors derived from census data on fuels and the industry survey data on purchased electricity. In 1971 the energy consumption was 34,400 BTU per lb and 31,800 BTU per lb in 1973, or 34% higher in 1971 and 57% higher in 1973 than the survey based figures.

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The table below shows a comparison of fuels use (excluding purchased electricity) in 1971 according to census versus according to the industry survey.

1971 Fuels Use

Item	Percent of Fuel BTUs: Census	Percent of Fuel BTUs: Industry Survey
Fuel Oils	21%	24%
Coal	46%	47%
Natural Gas	33%	29%
Total Fuel BTUs	129,500 Billion BTUs	85,800 Billion BTUs

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The table following presents expected major raw material requirements in 1974, based on the average production.

Fiber and Major Raw Material	Lb Material [1] Per Lb Product	Percent [1] Annual Production Represented	SIC 2824 [2] 1974 Average Requirement (million lbs)
POLYESTER			
. Dimethyl Terephthalate and	1.01	80% [3]	2,570
Ethylene Glycol	0.35		890
. Terephthalic Acid and	0.90	20% [3]	572
Ethylene Glycol	0.40		254
NYLON			
. Caprolactam	1.01	35%	804
. Adipic Acid and	0.65	65%	960
Hexamethylene Diamine	0.50		739
ACRYLIC AND MODACRYLIC			
. Acrylonitrile and	0.90	90%	623
Vinyl Monomers	0.10		69
. Acrylonitrile and	0.60	10%	46
Vinyl Monomers	0.40		31

(1) Source: Textile Economics Bureau
(2) Snell estimates representing roughly 98% of the industry's average 1974 requirement
(3) Source: Technical industry spokesman

2. GEOGRAPHIC PATTERN OF USE

The principal outputs from the tasks of this subsection are "Required Tables" and analysis of findings.

2.1 Task I, Geographic Pattern of The Industry's Energy Related Profile - 1971 to 1973

Exhibits VII-2-6 and 7 present the geographic distribution of energy use by SIC 2824 industry for 1971 and 1973, respectively. Virginia, North Carolina, South Carolina and Tennessee account for almost 95% of energy use.

2.2 Task II, Geographic Pattern of Employment and Shipments

The same states also account for almost all shipments and employment, shown in Exhibit VII-2-8.

2.3 Task III, Shifts in the Patterns

In terms of United States total figures, there was a 50% increase in the value of shipments from 1971 to 1973. Employment increased 15%. The increases were most significant in the Carolinas.

3. FUEL AND ENERGY SUPPLY SITUATION

The principal outputs from the tasks of this subsection are analysis of findings from industry sources and review of in-house information.

3.1 Task I, "Normal" Stocks of Materials

Fiber inventories have been low. Normal stocks are 5 or 6 weeks supply. End-of-month stocks versus shipments are shown below for early 1974.

	February 1974 Stock		
Fiber	End-of-Month Inventory (million lbs)	Shipments (million lbs)	Inventory As Weeks Supply
Nylon Yarn	107	127	3.4
Polyester Yarn	67	112	2.4
Polyester Staple	79	122	2.6

Source: Textile Economics Bureau

According to the Textile Economics Bureau, raw material shortages have resulted during the fourth quarter of 1973 and first quarter of 1974 in an approximately 10% shortfall in output versus available capacity, industry-wide. This source reports that the potential demand for the output represented by this shortfall existed during these quarters.

The production of acrylic staple and tow was singled out as a particularly affected sector. Output during the first two months of 1974 represented an approximately 81% capacity utilization, accounting for a theoretical shortfall of about 150 million lbs. During the month of April, an approximately 87% capacity utilization is projected. "Normal" annual capacity utilization has been over 90%. Acrylonitrile shortages are identified as a principal cause of the shortfalls. Shortages of nylon intermediates were also reported.

According to industry sources, fuel shortages have not been a major problem. Quantitative data on normal stocks of fuels was developed for fuel oils and coal, shown in Required Table 9, presented as Exhibit VII-2-9.

3.2 Task II, Shifts in Stocks

No evidence was found of significant shifts in the stocks of fuels. The shifts in raw material and product inventories are discussed above under 3.1.

3.3 Task III, Captive Use

Exhibit VII-5 shows that in 1973 from 70% to nearly 100% of electricity was purchased. For Nylon 6,6 about 20% of electricity was captively produced, while for polyesters this was over 30%.

No quantified data was identified on captive production of fuels, and therefore, Required Table 10 is not available.

3.4 Task IV, Sources of Supply

Suppliers include refineries, wholesalers of fuel oils, mining companies, etc.

3.5 Task V, Proportion by Type of Supplier

Only qualitative information was identified regarding the proportion of fuels by supplier, and therefore Required Table 11 is not available.

3.6 Task VI, Seasonality of Use

There is a seasonal variation in the consumption of fuels for the production of energy.

Total BTU consumption of energy varies about $\pm$ 8% from the arithmetic means of the seasonal extremes.

- Greatest consumption is in the summer.

- Least consumption is in the spring and fall followed closely by the consumption in the winter months.

Electricity consumption varies about $\pm$ 20% from the arithmetic mean of the seasonal extremes.

- Greatest consumption is in the summer.

- Least consumption is in the winter, followed closely by the consumption in the spring and fall months.

Heating requirements in the winter cancel to a certain degree the lower electricity requirements in these months in determining total consumption of fuels.

Since the industry is concentrated mainly in the South Atlantic states, the seasonal variations in fuel consumption at the industry level is characteristic of that area.

Required Table 12 is not presented because insufficient data was developed to quantify these trends as a function of specific fuel categories.

4. SUBSTITUTABILITY AND CONSERVATION OF MAJOR FUELS AND PETROLEUM PRODUCTS

The findings under this section were developed through the assistance of a technical industry spokesman working with the Textile Economics Bureau, review of secondary sources and review of in-house information.

4.1 Task I, Major Processes

Since yields are already 95% or better due to the highly competitive nature of the industry, the opportunity for conservation of raw materials is limited.

There is a reasonable degree of flexibility in fuels substitution.

- Shift from coal to oil, gas or other fuels is possible
- Shift back to coal is possible in facilities originally designed for coal use
- Shift to coal is not possible in the short run in facilities designed for other fuels

The immediate opportunity to conserve fuels and energy is limited to more efficient use of lighting, etc. and savings in excess of 1% or 2% should not be expected.

4.2 Task II, Quantification of the Major Substitutability and Conservation Opportunities

In shifting from petroleum based fuels to coal, savings of petroleum based fuels or gas can be achieved:

- About 4 barrels of oil for each ton of coal
- About 25 MCFT of natural gas for each ton of coal

The industry supplies about one fourth of its energy needs from coal. An opportunity exists for shifting back to coal from oil and gas.

4.3 Task III, Principal Constraints

The principal constraints on the possibility of shifting from petroleum-based fuels to coal for power generation are original facility design, time and costs.

- Facilities initially designed for coal and not stripped of coal handling capabilities can be converted back to coal burning in the near-term.

- In the long-term, essentially all oil or gas facilities can be substituted by coal burning, if this is environmentally acceptable. For the same output the capital costs of a coal burning unit can be five times those of an oil or gas facility, not including environmental controls.

- In certain states, strict environmental laws may apply a further constraint on the substitutability of coal for petroleum-based fuels.

4.4 Task IV, Plant Level Operating Characteristics

The production of the noncellulosic man-made fibers is primarily dependent upon the supply of raw materials and on fuels to generate the power required for the primary reaction.

- The output of fibers is directly proportional to the supply of raw materials.

- The output of fibers is essentially directly proportional to the supply of fuel for power generation.

- Fiber plants typically must be operated at over 80% of capacity to turn a profit. Management is concerned when capacity utilization falls below 90%.

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4.5 Task V, Capital Stock (1973)

The 1973 gross book value of fixed assets was about 4.5 billion. This estimate is based on the following:

- The 1972 Census of Manufactures indicates that the gross book value of fixed assets was $3.8 billion in 1971 and in 1972 capital expenditures were $370 million

- The capacity increase from 1972 to 1973 was about 650 million lbs from Exhibit VII-9. At $0.75 per pound of production capacity 1973 estimated capital expenditures were roughly $500 million

- It is assumed that $200 million of gross assets were retired during 1972 and 1973. 1973 production capacity was about 7.0 billion lbs per year, shown in Exhibit VII-9. The replacement value of present production capacity is roughly $5 to $6 billion at $0.75 per pound of capacity.

4.6 Task VI, Planned Capital Investment (1974)

There appear to be continued, but more cautious, plans for major capital investment in the SIC 2824 industry for 1974. Capital expenditures equal to the 1973 expenditures may occur.

4.7 Task VII, Changes to Investment Plans

The primary effect of potential coal substitution for gas or oil would be to increase capital investment. Overall, more caution is expected in long range plans with particular attention given to assuring raw material supplies.

5. INTRA-INDUSTRY EFFICIENCY

The findings in this section have been developed through an analysis of industry and in-house data and with the assistance of a technical industry spokesman working with the Textile Economics Bureau.

5.1 Task I, Energy Efficiency

SIC 2824 industry has been growing rapidly with an 18% production capacity gain in 1972 over 1971 and a 10% gain in 1973. Plants are large and modern. Appreciable variations exist in the energy needs of one fiber process to another, documented in Exhibit VII-5 and discusssion under Task 1.3 of subsection 1. The significant improvements in the energy efficiency of the industry are possibly attributable to its highly competitive nature, rapid growth and modern facilities.

5.2 Task II, Major Factors Affecting Efficiency

See the discussion above.

6. PRINCIPAL CONSTRAINTS ON CURRENT INDUSTRY OPERATIONS

The findings presented in this section have been obtained through the assistance of a technical industry spokesman and through the analysis of secondary sources and in-house information.

6.1 Task I, Important Constraints

Despite slowdowns in the auto industry, the organic fiber industry expects an increase in shipments in 1974. Due to persisting strong demand in other sectors during the first quarter substantial reduction or curtailment in the growth of fiber production will be the result of raw materials shortages, if demand persists.

Employment in the industry has increased by 13% from 1972 to 1973. During 1974 employment levels are expected to increase roughly as capacity increases occur.

6.2 Task II, Most Serious Constraint

Potential raw material shortages are the most serious constraint. The materials situation is summarized under Task I of subsection 3.

6.3 Task III, Shortfall in Supply and Price Increases

A 10% shortfall in supply was cited for the first half of 1974 in relation to demand due to raw material shortages. 1974 increases of about 10% were projected over end of 1973 prices.

6.4 Task IV, Outputs Critical to Subsequent Production

The products of SIC 2824 industry find use throughout the economy. According to industry sources, significant interruptions or reductions in the level of output by the manmade fibers industry can have a major impact on employment in the textile industry.

EXHIBIT VII -1
FEO: USDC
DEFINITION OF SIC 2824 (1)

SIC 2824 SYNTHETIC ORGANIC FIBERS, EXCEPT CELLULOSIC

Establishments primarily engaged in manufacturing synthetic organic fibers, except cellulosic (including those of regenerated proteins, and of polymers or copolymers of such components as vinyl chloride, vinylidene chloride, linear esters, vinyl alcohols, acrylonitrile, ethylenes, amides, and related polymeric materials) in the form of monofilament, yarn, staple or tow suitable for further manufacturing on spindles, looms, knitting machines or other textile processing equipment. Establishments primarily engaged in manufacturing textile glass fibers are classified in Industry 3229.

Acrylic fibers
Acrylonitrile fibers
Anidex fibers
Casein fibers
Elastomeric fibers
Fibers, man-made: except cellulosic
Fluorocarbon fibers
Horsehair, artificial: nylon
Linear esters fibers
Modacrylic fibers
Nylon fibers and bristles
Olefin fibers
Organic fibers, synthetic: except cellulosic
Polyester fibers
Polyvinyl ester fibers
Polyvinylidene chloride fibers
Protein fibers
Saran fibers
Soybean fibers (man-made textile materials)
Vinyl fibers
Vinylidene chloride fibers
Yarn, organic man-made fiber except cellulosic
Zein fibers

Source: 1972 Standard Industrial Classification Manual

(1) The 1972 SIC definition is the same as that used in the 1967 census.

EXHIBIT VII-2-1
FEO:USDC
REQUIRED TABLE 1

Proportion of Industry Output Accounted for by Each Major Process, 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Process and Major Products	Percent of 1973 Shipments Value		Percent of 1973 Production Volume 1/	
Polyamide fibers, except nontextile monofilaments	38.2%		30.8%	
Filament yarn and textile monofilaments		29.7%		22.4%
Other		8.5		8.4
Other noncellulosic synthetic organic fibers	51.2		58.6	
Acrylic and modacrylic		8.9		10.5
Polyester		36.0		40.7
Polyolefin		4.7		7.0
Other (except glass)		1.6		0.4
Secondary products and miscellaneous receipts	10.6		10.6	
Total Industry (Percent)	100.0		100.0	
(Actual)	$4,854,900,000		6,916,500,000	

1/ Production volume expressed in pounds.

Source: Exhibits VII-3 and VII-4.

EXHIBIT VII - 2-2a
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume, 1971 and 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Nylon 66 (1)

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	1,000 barrels	16.1			16.1	53.9			53.9
3	Residual fuel oil	1,000 barrels	1,460			1,460	1,705			1,705
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	1,000 Short tons	285			285	180			180
8	Natural gas	Billion Cu. Ft.	4.3			4.3	3.1			3.1
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	Million KWH	1,010			1,010	1,170			1,170
12	GRAND TOTAL									

Source: (1) Based on data in Exhibit VII - 5.

EXHIBIT VII - 2-3a
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in BTU's, 1971 and 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Nylon 66

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	Billion BTUs	90			90	310			310
3	Residual fuel oil	Billion BTUs	9,180			9,180	10,720			10,720
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	Billion BTUs	7,460			7,460	4,780			4,780
8	Natural gas	Billion BTUs	4,450			4,450	3,200			3,200
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	Billion BTUs	10,740			10,740	12,440			12,440
12	GRAND TOTAL					31,920				31,450

EXHIBIT VII - 2-4a
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH equivalents, 1971 and 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Nylon 66

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	Million KWH	30			30	90			90
3	Residual fuel oil	Million KWH	2,690			2,690	3,140			3,140
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	Million KWH	2,190			2,190	1,400			1,400
8	Natural gas	Million KWH	1,310			1,310	940			940
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)(1)	Million KWH	3,140			3,140	3,640			3,640
12	GRAND TOTAL					9,360				9,210

(1) Expressed as fuel equivalents.

EXHIBIT VII - 2-2b
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Volume, 1971 and 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Nylon 6

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures				–					
2	Middle distillates	1,000 barrels	25.9			25.9	78.8			78.8
3	Residual fuel oil	1,000 barrels	200.7			200.7	425.5			425.5
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	1,000 short tons	76.3			76.3	96.5			96.5
8	Natural gas	billion cu. ft.	0.62			0.62	1.05			1.05
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	299.3			299.3	533.0			533.0
12	GRAND TOTAL									

Source: Based on data in Exhibit VII-5.

EXHIBIT VII - [illegible]
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billion BTU's, 1971 and 1973.

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Nylon 6

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	billion BTU s	150			150	460			460
3	Residual fuel oil	billion BTU s	1,260			1,260	2,680			2,680
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	billion BTU s	2,000			2,000	2,530			2,530
8	Natural gas	billion BTU s	640			640	1,090			1,090
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTU s	3,170			3,170	5,650			5,650
12	GRAND TOTAL		7,220			7,220	12,410			12,410

EXHIBIT VII - 2-4b
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Million KWH Equivalent

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Nylon 6

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	Million KWH	40			40	140			140
3	Residual fuel oil	Million KWH	370			370	780			780
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	Million KWH	590			590	740			740
8	Natural gas	Million KWH	190			190	320			320
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)[1]	Million KWH	930			930	1,650			1,650
12	GRAND TOTAL					2,120				3,630

(1) Expressed as fuel equivalents.

EXHIBIT VII-2-2c
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Volume, 1971 and 1973(1)

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Polyester

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	1,000 barrels	99.3			99.3	156.9			156.9
3	Residual fuel oil	1,000 barrels	529.0			529.0	1433.7			1433.7
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	1,000 short tons	369.3			369.3	249.8			249.8
8	Natural gas	billion cu. ft.	9.32			9.32	9.10			9.10
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	1153.0			1153.0	2126.5			2126.5
12	GRAND TOTAL									

Source: (1) Based on data in Exhibit VII-5.

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EXHIBIT VII - 2-3c
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billion BTU's, 1971 and 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Polyester

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures	billion BTUs	580			580	910			910
2	Middle distillates	billion BTUs	3,330			3,330	9,330			9,330
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total	billion BTUs	9,680			9,680	6,550			6,550
7	Coal	billion BTUs	9,620			9,620	9,390			9,390
8	Natural gas									
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTUs	12,220			12,220	22,540			22,540
12	GRAND TOTAL					35,430				48,720

EXHIBIT VII - 2-4c
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Million KWH Equivalents, 1971 and 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Polyesters

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates	million KWH	170			170	270			270
3	Residual fuel oil	million KWH	970			970	2,730			2,730
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	million KWH	2,840			2,840	1,920			1,920
8	Natural gas	million KWH	2,830			2,830	2,760			2,760
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)(1)	million KWH	3,570			3,570	6,590			6,590
12	GRAND TOTAL					10,380				14,270

(1) Expressed as fuel equivalents.

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EXHIBIT VII - 2-2d
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Volume 1971 and 1973.(1)

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Acrylic and Modacrylic

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	1,000 barrels	83.7			83.7	27.3			27.3
3	Residual fuel oil	1,000 barrels	379.4			379.4	3770.7			3770.7
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	1,000 short tons	560.7			560.7	523.4			523.4
8	Natural gas	billion cu. ft.	3.748			3.748	1.886			1.886
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	350.3			350.3	414.4			414.4
12	GRAND TOTAL									

Source: (1) Based on data in Exhibit VII-5.

EXHIBIT VII - 2-3d
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billion BTU's, 1971 and 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Acrylic and Modacrylic

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	billion BTUs	490			490	160			160
3	Residual fuel oil	billion BTUs	2,390			2,390	23,710			23,710
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	billion BTUs	14,690			14,690	13,710			13,710
8	Natural gas	billion BTUs	3,870			3,870	1,950			1,950
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTUs	3,710			3,710	4,390			4,390
12	GRAND TOTAL					25,150				33,920

EXHIBIT VII - 2-4d
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Million KWH Equivalent, 1971 and 1973.

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Acrylic and Modacrylic

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates	million KWH	140			140	50			50
3	Residual fuel oil	million KWH	700			700	6,340			6,340
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	million KWH	4,310			4,310	4,020			4,020
8	Natural gas	million KWH	1,140			1,140	570			570
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)(1)	million KWH	1,090			1,090	1,290			1,290
12	GRAND TOTAL					7,380				12,870

(1) Expressed as fuel equivalents.

EXHIBIT VII - 2-3d
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billion BTU's, 1971 and 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Acrylic and Modacrylic

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates	billion BTUs	490			490	160			160
3	Residual fuel oil	billion BTUs	2,390			2,390	23,710			23,710
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	billion BTUs	14,690			14,690	13,710			13,710
8	Natural gas	billion BTUs	3,870			3,870	1,950			1,950
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTUs	3,710			3,710	4,390			4,390
12	GRAND TOTAL					25,150				33,920

EXHIBIT VII - 2-4d
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Million KWH Equivalent, 1971 and 1973.

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Acrylic and Modacrylic

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	million KWH	140			140	50			50
3	Residual fuel oil	million KWH	700			700	6,340			6,340
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	million KWH	4,310			4,310	4,020			4,020
8	Natural gas	million KWH	1,140			1,140	570			570
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)[(1)]	million KWH	1,090			1,090	1,290			1,290
12	GRAND TOTAL					7,380				12,870

(1) Expressed as fuel equivalents.

EXHIBIT VII - 2-2e
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume, 1971 and 1973(1)

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Olefins

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	1,000 barrels	22.2			22.2	45.0			45.0
3	Residual fuel oil	1,000 barrels	9.2			9.2	28.3			28.3
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	1,000 short tons	26.3			26.3	13.8			13.8
8	Natural gas	billion cu. ft.	2.314			2.314	2.609			2.609
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	420.5			420.5	531.3			531.3
12	GRAND TOTAL									

Source: (1) Based on data in Exhibit VII-5.

EXHIBIT VII - 2-3e
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billion BTU s, 1971 and 1973.

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Olefins

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	billion BTUs	130			130	260			260
3	Residual fuel oil	billion BTUs	60			60	180			180
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	billion BTUs	690			690	360			360
8	Natural gas	billion BTUs	2,390			2,390	2,690			2,690
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTUs	4,460			4,460	5,630			5,630
12	GRAND TOTAL		7,730			7,730	9,120			9,120

EXHIBIT VII - 2-4e
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalents.

SIC 2824 Industry Organic Fibers, Noncellulosic

Process Olefins

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	million KWH	40			40	80			80
3	Residual fuel oil	million KWH	20			20	50			50
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	million KWH	200			200	110			110
8	Natural gas	million KWH	700			700	790			790
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)(1)	million KWH	1,300			1,300	1,650			1,650
12	GRAND TOTAL		2,260			2,260	2,690			2,690

(1) Expressed as fuel equivalents.

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EXHIBIT VII-2-5
FEO: USDC
REQUIRED TABLE 5

Industry Consumption of Fuels, Petroleum Products, and Energy by Type - 1971, 1973, and 1974

SIC 2824 Industry Organic Fibers, Noncellulosic

Line No.	Type of Energy or Material	Unit of Measure	Volume 1971(1)	Volume 1973(2)	Volume 1974(2)	Bil. BTU s(3) 1971	Bil. BTU s(3) 1973	Bil. BTU s(3) 1974	% Change 1971-73	% Change 1973-74	% of Total BTU s 1971	% of Total BTU s 1974
1	Propane, butane, and mixtures											
2	Middle distillates	1,000 barrels	1,729.5	3,170	3,430	10,075	18,470	19,980	83	8.2	5.9	8.4
3	Residual fuel oil	1,000 barrels	2,688.6	5,050	5,460	16,900	31,750	34,330	88	8.1	10.0	14.4
4	Chemical feedstocks											
5	Other petroleum, products, total											
6	Petroleum products, total											
7	Coal	1,000 short tons	2,296.8	2,290	2,470	60,180	60,000	64,720	(0.3)	7.9	35.5	27.3
8	Natural gas	billion cu. ft.	41.0	51.2	55.3	42,310	52,840	57,070	25	8.0	24.9	24.0
9	Fuels, n.e.c. total											
10	Other fuels, total											
11	Electrical energy (purchased only) (2)	million KWH	3,790(2)	5,350	5,780	40,200	56,700	61,300	41	8.1	23.7	25.8
12	GRAND TOTAL		(X)	(X)	(X)	169,665	219,760	237,400	30	8.0	100%	100%

Source:

(1) Based on census "Fuels and Electric Energy Consumed," MC72(SR)-6.
(2) The energy factors from Exhibit VII-6 multiplied by total production from Line 1 of Exhibit VII-4. For 1974 the 1973 energy factor is applied to the average expected production in 1974.
(3) BTUs have been expressed in billions rather than millions.

EXHIBIT VII - 2-6 a
FEO:USDC
REQUIRED TABLE 6

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit

SIC 2824 Industry Organic Fibers, Noncellulosic Year 1971

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
1	United States		1,729.5	2,687.6			27,000	2,296.8	41		102,600	40,200	169,700
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.												
8	R.I.												
9	Conn.												
10	Middle Atlantic												
11	N.Y.												
12	N.J.												
13	Penn.												
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio												
17	Ind.												
18	Ill.												
19	Mich.												
20	Wisc.												
21	W. North Central												
22	Minn.												
23	Iowa												
24	Mis.												
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU's)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.												
33	D.C.												
34	Va.		353	550			5,513	477	8.55		21,315	3,100	40,300
35	W. Va.												
36	N.C.		343	532			5,349	463	8.29		20,634	7,900	38,800
37	S. C.		268	417			4,180	362	5.07		10,165	6,200	30,300
38	Ga.												
39	Fla.												
40	S. Central												
41	Ky												
42	Tenn.		457	711			7,129	617	11.05		27,654	10,500	51,700
43	Ala.												
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas												
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

(1) Based on the geographic distribution of BTUs from Exhibit VII - 2-8 and assuming the national distribution of fuels from Exhibit VII - 2-5.

(2) States for which SIC 2824 is not applicable or for which data is not available are shown in Exhibit VII - 2-8.

EXHIBIT VII-2-7a
FEO:USDC
REQUIRED TABLE 7

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit

SIC 2824 Industry Organic Fibers, Noncellulosic Year 1973

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
1	United States		3,170	5,050			50,200	2,290	51.2		112,800	56,700	219,800
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.												
8	R.I.												
9	Conn.												
10	Middle Atlantic												
11	N.Y.												
12	N.J.												
13	Penn.												
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio												
17	Ind.												
18	Ill.												
19	Mich.												
20	Wisc.												
21	W. North Central												
22	Minn.												
23	Iowa												
24	Mis.												
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Petroleum Products: Distillates (Thousand Barrels)	Petroleum Products: Residual (Thousand Barrels)	Petroleum Products: Feedstocks (Thousand Barrels)	Petroleum Products: Other (Thousand Barrels)	Petroleum Products: Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Other Fuels: Natural Gas (Bil. Cu. Ft.)*	Other Fuels: Fuels, n.e.c. (Bil. BTU s)*	Other Fuels: Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.												
33	D.C.												
34	Va.		600	940			9,410	430	9.6		21,140	10,650	41,210
35	W. Va.												
36	N.C.		670	1,070			10,590	480	10.8		23,870	12,000	46,480
37	S. C.		540	860			8,550	390	8.7		19,230	9,700	37,450
38	Ga.												
39	Fla.												
40	S.Central												
41	Ky												
42	Tenn.		800	1,270			12,620	570	12.9		28,430	14,300	55,330
43	Ala.												
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas												
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.
(1) Based on the geographic distribution of BTUs from Exhibit VII - 2-8 and assuming the national distribution of fuels from Exhibit VII - 2-5.
(2) States for which SIC 2824 is not applicable, or for which data is not available are shown in Exhibit VII - 2-8.

EXHIBIT VII-2-3a
FEO:USDC
REQUIRED TABLE 5

Shipments, Employment, and Fuels and Energy Consumed by Geographic Unit, 1971 and 1973

SIC 2824 Industry Organic Fibers, Noncellulosic

Line Number	Geographic Unit	Value of Shipments ($ Millions) 1971	1973	% Change	Employment 1971	1973	% Change	Fuels and Energy (6) (Bil. BTUs) 1971	1973	% Change
1	United States	3,241 (4)	4,855 (4)	50 (5)	68,920 (1)	79,430 (2,3)	15 (5)	169,700	219,800	30
2	NORTH EAST	(NA)								
3	New England									
4	Maine									
5	N.H.									
6	Vermont									
7	Mass.									
8	R.I.									
9	Conn.									
10	Middle Atlantic	(NA)								
11	N.Y.									
12	N.J.									
13	Penn.									
14	NORTH CENTRAL	(NA)								
15	E. North Central									
16	Ohio									
17	Ind.									
18	Ill.									
19	Mich.									
20	Wisc.									
21	W. North Central									
22	Minn.									
23	Iowa									
24	Mis.									
25	N.D.									
26	S.D.									
27	Neb.									
28	Kans.									

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Value of Shipments ($ Millions) 1971	1973	% Change	Employment 1971	1973	% Change	Fuels and Energy (Bil. BTU s)* 1971	1973	% Change
29	SOUTH	(NA)								
30	S. Atlantic	(NA)								
31	Del.	(NA)								
32	Md.	(NA)								
33	D.C.									
34	Va.	553	660(5)	12	4,030	14,930	6	34,550	41,210	19
35	W. Va.									37
36	N.C.	665	1,200(5)	81	13,620	16,850	24	33,930	46,480	
37	S.C.				10,640	13,570	28	26,200	37,450	43
38	Ga.	(NA)								
39	Fla.									
40	S. Central	(NA)								
41	Ky.									
42	Tenn.									
43	Ala.	(NA)			18,157	20,040	10	44,680	55,330	24
44	Miss.									
45	Ark.									
46	La.	(NA)								
47	Okla.									
48	Texas									
49	WEST									
50	Mountain									
51	Mont.									
52	Idaho									
53	Wyo.									
54	Colo.									
55	N.M.									
56	Ariz.									
57	Utah									
58	Nev.									

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT VII-2-8c

Line Number	Geographic Unit	Value of Shipments ($ Millions)			Employment			Fuels and Energy (Bil. BTU's)*		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
59	Pacific									
60	Wash.									
61	Ore.									
62	Cal.									
63	Alas.									
64	Haw.									

* BTU's & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Source: (1) From County Business Patterns (CBP), 1971.
(2) From Exhibit VII-8
(3) 1972 CBP total U. S. employment is 70,155. The estimated national change from 1972 to 1973 is 13% according to Bureau of Labor Statistic data. The 1973 employment in each state is estimated by applying a 13% change uniformly to the 1972 CBP figures.
(4) From Exhibit VII-3.
(5) Each percent change in employment is equal to a 3.3% change in value of shipments. This factor was used in estimating 1973 value of shipments.
(6) Prorated according to the state to national employment ratio.

Stocks of Fuels and Petroleum Products by Type, 12/31/73 and 3/31/74

SIC 2823 and 2824 Industry Man-Made Fibers, Cellulosic and Noncellulosic

Line Number	Type of Energy or Material	Stocks (# of days supply related to average daily requirements in next quarter) (1)					
		As of December 31			As of March 31		
		1971	1972	1973	1972	1973	1974
1	Propane						
2	Butane						
3	Propane Butane Mixture						
4	Middle Distillates(2)	17	16	38	15	15	30
5	Residual Fuel Oil(3)	23	15	31	18	16	21
6	Chemical Feedstocks						
7	Other Petroleum Products, total						
8	Coal(4)	39	37	40	43	40	43
9	Natural Gas						
10	Fuels, n.e.c., total						

(1) Source: Textile Economics Bureau.
(2) 8 companies.
(3) 10 companies.
(4) 6 companies.

EXHIBIT VII-3
FEO:USDC
SIC 2824 - VALUE OF SHIPMENTS--1967, 1971-1974
(Dollars in Millions)

Line	Item	1967	1971	1972	1973	1974 [6] Low	1974 [6] High
1.	Value of all products and services sold by SIC 2824 industry [1]	$2,033.2	$3,241.4	$3,674.8	$4,854.9	$5,341	$6,244
2.	Value of SIC 2824 products shipped by SIC 2824 industry [2]	1,863.9	2,764.9	3,285.2	4,340.2	4,776	5,583
3.	Value of SIC 2824 products shipped by all industries [3]	1,974.1	2,821.3	3,359.2	4,438.0	4,882	5,708
4.	Ratio of SIC 2824 products shipped by SIC 2824 industry to those shipped by all industries (coverage ratio) [4]	0.94	0.98	0.98	0.98	0.98	0.98
5.	Value of major SIC 2824 products shipped by SIC 2824 industry: [5]						
	Polyamide fibers except nontextile monofilaments:	$1,008.8	$1,149.1	$1,509.1	$1,855.3	$2,041	$2,261
	Filament yarn and textile monofilaments	929.8	NA	1,203.0	1,441.6	1,586	1,698
	Other	79.0	NA	306.1	413.7	455	563
	Other noncellulosic synthetic organic fibers:	854.8	1,615.8	1,776.1	2,484.9	2,735	3,322
	Acrylic and modacrylic	271.3	NA	324.6	433.2	477	514
	Polyester	467.0	NA	1,223.0	1,747.7	1,923	2,402
	Polyolefin	NA	NA	166.0	227.9	251	313
	Other (except glass)	NA	NA	62.5	76.1	84	93

Footnotes:

(1) Figures for 1967, 1971, and 1972 obtained from Sources (a), (b) and (c). Figures for 1973 and 1974 obtained from value in line 2 using same ratio as for 1972.

(2) Figures for 1967, 1971 and 1972 obtained from values in line 3 using ratios given in line 4. Figures for 1973 and 1974 are sums of figures in individual product categories.

(3) Figures for 1967, 1971 and 1972 obtained from Sources (a), (d) and (c). Figures for 1973 and 1974 obtained from value in line 2 using ratio given in line 4.

(4) Ratios for 1967 and 1972 obtained from Sources (a) and (c). Ratio for 1971-1974 assumed to be constant.

(5) Figures for 1967, 1971 and 1972 obtained from Sources (a), (d) and (c) modified by ratios given in line 4. Figures for 1973 obtained from 1972 figures by applying the ratios of volumes shipped in 1972 and 1973 (Source (e)) and applying a 10% price increase.

(6) Figures for 1974 built up from individual product category figures which are estimated to range from a minimum of zero growth to a maximum of a continuation of the historical growth rate from 1967 to 1973. In all cases, a 10% increase in prices over 1973 is assumed.

Sources:

(a) "Industry Statistics," 1967 Census of Manufacturers, U.S. Department of Commerce, Volume II, Part 2, Major Groups 25-33, 1971, pp. 28B1-25.

(b) "General Statistics for Industry Groups and Industries," Annual Survey of Manufacturers - 1971, U. S. Department of Commerce, Publication M71(AS)-1, April 1973.

(c) "Organic Fibers, Noncellulosic, SIC 2824," 1972 Census of Manufacturers, U.S. Department of Commerce, Publication MC72(P)-28B-4, December 1973.

(d) "Value of Product Shipments," Annual Survey of Manufacturers - 1971, U.S. Department of Commerce, Publication M71(AS)-2, October 1973.

(e) "Textile Organon," Volume XLV, No. 1-2, January-February 1974.

EXHIBIT VII-4
FEO: USDC
SIC 2824 - PRODUCTION VOLUME--1967, 1971-1974
(Pounds in Millions)

Line	Item	1967	1971	1972	1973	1974 [7] Low	1974 [7] High
1.	Total production by SIC 2824 industry [1]	2,423.8	4,932.0	5,858.9	6,916.5	6,916	8,033
2.	Total production of SIC 2824 products by SIC 2824 industry [2]	2,221.9	4,206.9	5,248.6	6,183.1	6,182	7,379
3.	Total production of SIC 2824 products by all industries [3]	2,353.3	4,292.8	5,355.7	6,309.4	6,309	7,529
4.	Ratio of production of SIC 2824 products by SIC 2824 industry to total production of SIC 2824 products by all industries [4]	0.94	0.98	0.98	0.98	0.98	0.98
5.	Production of major SIC 2824 products by SIC 2824 industry: [5]						
	Polyamide fibers except nontextile monofilaments:	1,009.5	1,563.4	1,935.0	2,131.2	2,131	2,415
	Filament yarn and textile monofilaments	891.9	1,213.1	1,434.6	1,551.1	1,551	1,701
	Other	117.6	350.3	500.4	580.1	580	714
	Other noncellulosic synthetic organic fibers:	1,212.4	2,643.5	3,313.6	4,051.9	4,051	4,964
	Acrylic and modacrylic	375.5	534.3	613.4	727.3	727	812
	Polyester [6]	677.7	1,780.6	2,273.4	2,816.8	2,817	3,537
	Polyolefin [6]	155.4	314.0	406.5	480.4	480	577
	Other (except glass) [6]	3.8	14.7	20.3	27.4	27	38

Footnotes:

(1) Figures stated in "equivalent" pounds of SIC 2824 products calculated from figures in line 2, by applying the ratio of the total value of SIC 2824 products and services sold by SIC 2824 industry to the value of SIC 2824 products shipped by the industry (see Exhibit VII-3).

(2) Figures obtained from quantities in line 3 using ratios given in line 4.

(3) Figures for 1967 and 1971-1973 obtained from Source (a).

(4) Ratios are those which were established for the value of shipments for this industry (see Exhibit VII-3).

(5) Figures for 1967 and 1971-1973 calculated from total production of these products by all industries by applying the ratios given in line 4.

(6) Figures for these product categories based on data in Source (a) modified as follows:
- Polyester: 0.98 (other yarn and monofilaments) + polyester staple and tow.
- Polyolefin: Polyolefin yarn and monofilaments + 0.98 (other staple and tow)
- Other: 0.02 (other yarn and monofilaments + other staple and tow)

(7) Figures for 1974 built up from quantities estimated for individual product categories which are estimated to range from a minimum of zero growth to a maximum of a continuation of the historical growth rate from 1967 to 1973.

Sources:

(a) "Textile Organon," Volume XLV, No. 1-2, January-February 1974.
(b) Personal interview with Mr. Charles Whitehead, Textile Economics Bureau, New York, March 1, 1974.
(c) "Industry Statistics," 1967 Census of Manufacturers, Vol. II, Part 2, Major Groups 25-33, U.S. Department of Commerce, 1971, pp. 28B 1-25.
(d) "Organic Fibers, Noncellulosic, SIC 2824," 1972 Census of Manufacturers, U.S. Department of Commerce, Publication MC72 (P)-28B-4, December 1973.

EXHIBIT VI-5 and VII-5
FEO: USDC
ENERGY CONSUMPTION IN FIBER PRODUCTION (1)

Product and Year	Reporters(2) Percent of Total Production	Energy Consumed(6) Per Lb. Product BTUs/Lb. (000)	Coal-Tons	#2 Oil(6) (000 Barrel)	#6 Oil(6) (000 Barrel)	Natural Gas (000 Cu. Ft.)	Purchased Electricity (000 KWH)	Percent of Electricity Purchased
Rayon - 1971	76	61.9	1,460,480	60.98	289.36	1,615,520	86,163	5%
- 1973	97	50.4	1,141,310	953.88	222.71	3,999,607	256,995	12%
Acetate - 1971	142(3)	67.2	1,290,121	101.57	129.12	6,529,701	326,321	32%
- 1973	144(3)	63.0	1,068,442	46.95	269.36	7,151,400	419,100	30%
Polyester - 1971	62	19.9	233,650	62.79	334.64	5,897,269	729,464	57%
- 1973	94	17.3	239,638	150.52	1,423.14	8,723,905	2,039,675	67%
Nylon 66 - 1971	(4)	25.0(7)	225,733	12.64	1,147.45	3,386,413	796,135	71%
- 1973	(4)	20.6(7)	180,478	53.33	1,687.14	3,071,668	1,161,446	79%
Nylon 6 - 1971	(4)		59,974	20.36	157.71	484,589	235,202	77%
- 1973	(4)		96,534	77.95	421.12	1,043,134	527,575	96%
Acrylic+ Modacryl. - 1971	100	47.1(5)	572,108	85.40	387.12	3,824,619	357,464	87%
- 1973	100	43.4(5)	534,042	27.88	3,847.62	1,924,106	422,894	88%
Olefin - 1971	51	24.6	13,689	11.55	4.76	1,208,966	218,334	91%
- 1973	48	19.0	6,751	22.02	13.86	1,277,359	260,221	93%

(1) Source: Textile Economics Bureau.
(2) With respect to figures compiled by the Textile Economics Bureau for the industry and published in Textile Organon, January-February 1974. SIC 2823 industry production of rayon and acetate covers about 90% of the total production of these fibers. SIC 2824 industry production of non-cellulosic fibers covers about 98% of the total production of these fibers. Dividing the fuel and energy quantities by the "% Reporting" and multiplying by the appropriate coverage ratio provides annual total figures for the appropriate fibers in each SIC.
(3) Total is more than 100% due to inclusion of cigarette tow and flake.
(4) Nylon 6+66 coverage was 77% for 1971 and 97% for 1973. Nylon 66 represents more than 2/3 of the total nylon output.
(5) These numbers are heavily weighted towards acrylic, 1973 shipments of which were more than 10 times those of modacrylic. Separate modacrylic cannot be shown because of disclosure.
(6) Snell estimates based on Textile Economics Bureau data.
(7) The top figure is for both nylons for 1971 and the bottom figure is for 1973.

EXHIBIT VII-6
FEO: USDC
SIC 2824 - ENERGY FACTORS - 1967, 1971, AND 1973
(Per Million Pounds Produced)

Line	Item	Units	Year		
			1967[1]	1971[1]	1973[2]
1	Production[1]	Million equivalent pounds	2,424	4,932	6,917
2	BTU equivalent of fuels	Billion BTUs	32.2	26.25	23.6
3	Coal	Thousand short tons	0.736	0.466	0.331
4	Distillates	Thousand barrels	0.136	0.351	0.459
5	Residual	Thousand barrels	0.176	0.545	0.730
6	Natural gas	Million cu. ft.	0.0107	0.0083	0.0074
7	Other fuels	Dollars		(Z)	(Z)
8	Fuels nsk.	Dollars		(Z)	(Z)
9	Electricity purchased	Million KWH	1.05	0.769[3]	0.773[3]
10	BTU equivalent of purchased electricity	Billion BTUs	11.1	8.15	8.19
11	Electricity generated less sold	Billion BTUs	0.41	NA	NA
12	BTU equivalent of fuels and purchased electricity	Billion BTUs	43.3	34.4	31.8

(1) Census data (except purchased electricity) from "Fuels and Electric Energy Consumed" MC67(S)-4 and MC72(SR)-6 divided by total production from Line 1 of Exhibit VII-4.
(2) Based on straight line extrapolation of the 1967 to 1971 trend for fuel items.
(3) Based on the data for the non-cellulosic fibers in Exhibit VII-5.

EXHIBIT VII-7
FEO: USDC
SIC 2824 - PRODUCT MIX--1967, 1971 TO 1973

Line	Item	1967	1971	1972	1973
		Million Lbs.			
1	Total Production by SIC 2824 industry	2,424	4,932	5,859	6,917
		Percent of Total Production by Weight			
2	Nylon	41.6%	24.6%	24.5%	22.4%
3	Acrylic	15.5	10.8	10.5	10.5
4	Polyester	28.0	36.1	38.8	40.7
5	Polyolefins	6.4	6.4	6.9	6.9
6	Other	8.5	22.1	19.3	19.5

Source: Snell estimates based on the data in Exhibit VII-4.

EXHIBIT VII-8
FEO: USDC
SIC 2823 AND 2824 - EMPLOYMENT--1971 TO 1973

	Total Employees			
	A	B	C	D
Year	SIC 2823 and 2824 After BLS [1]	SIC 2823 and 2824 After CBP [2]	SIC 2823	SIC 2824
1971	109,200	92,067 [2]	23,812 [2]	68,922 [2]
1972	114,600	92,616 [2, 3]	22,461 [2]	70,155 [2]
1973	122,300	99,063 [4]	19,631 [5]	79,432

(1) Private communication between Snell and the Bureau of Labor Statistics (BLS).
(2) County Business Patterns (CBP), 1971 and 1972.
(3) The ratio of B to A for 1972 is 0.81. Assume that this ratio holds for 1973.
(4) Total employees for fibers industry, A, for 1973 multiplied by 0.81 from (3) above.
(5) Based on a 1.26% decrease in capacity from 1972 to 1973 of rayon and acetate plants, after "Textile Organon," Vol. XLIV, No. 9, September 1973.

EXHIBIT VII-9
FEO: USDC
SIC 2823 AND 2824 - CAPACITY CHANGES --1970 TO 1973

	SIC 2823 Rayon and Acetate			SIC 2824 Non-Cellulosics			Combined SIC 2823 and 2824	
Year	Production Capacity (Mil. Lbs.)	Percent Change in Production Capacity	Year	Production Capacity (Mil. Lbs.)	Percent Change in Production Capacity	Year	Total Production Capacity (Mil. Lbs.)	Percent Change in Production Capacity
1970	1,713	(5.8) %	1970	4,862	11.39%	1970	6,575	6.92%
1971	1,614	(6.3)	1971	5,416	18.09	1971	7,030	12.49
1972	1,512	(1.3)	1972	6,396	10.06	1972	7,908	7.90
1973	1,493		1973	7,040		1973	8,533	

Source: (1) "Textile Organon," Vol. XLIV, No. 12, December 1973.

SECTION VIII

SIC 3011, TIRES AND INNER TUBES

Exhibit VIII-1, at the end of this section, presents a detailed industry definition. In 1971 value added by manufacture was $2,767 million according to the Annual Survey of Manufactures, while value of shipments was $5,232.2 million and total gross book value of depreciable assets was $2,827 million. The same source reports energy consumption of 19.6 billion KWH equivalents. County Business Patterns 1972, reports that about 200 establishments were classified in SIC 3011, with about 50 establishments with 500 or more employees.

The most important findings follow regarding the economic impact of the petroleum based materials shortages during 1973 and the first quarter of 1974:

- Fuel shortages have not been a principal constraint on industry operations.
- Material shortages have been of concern to the industry, but did not cause disruptions.
- Employment increases are not expected in 1974.
- No major near-term opportunities for substitutions or conservation of fuels were identified.
- Characterization of this industry assumes similar energy efficiency of major product groups per dollar value of shipments.

Exhibit VIII-2, following Exhibit VIII-1, features the Required Tables. These tables and supporting exhibits further define the industry's structure both in economic and energy terms.

All exhibits appear sequentially at the end of this section. Whenever electricity KWHs are expressed as BTUs, conversion is based on the nominal fuel requirements to generate the electricity.

1. MAJOR USES OF FUELS, ENERGY AND PETROLEUM PRODUCTS

The principal outputs from the tasks of this sub-section are "Required Tables" and analysis of findings.

1.1 Task I, Major Processes

The pneumatic tire is the characteristic product of this sector. It is the sector's most valuable product; the other products in the sector use manufacturing process steps that are quite similar to processes involved in tire building. Summary process flow sheets, Exhibits VIII-3-1, 2, and 3 illustrate the manufacturing steps involved in producing pneumatic tires of these three important categories.

- Bias and Bias Belted Tires
- Radial Tires
- Truck and Bus Tires

Pneumatic tires are constructed from strong textiles (typically rayon, nylon, polyester, glass, or steel) impregnated with polymers (synthetic and natural rubber) and overlaid with a tread of wear-resistant polymer such as styrene-butadiene rubber (SBR). These are built up individually by a skilled tire builder, and cured into the familiar toroidal shape under pressure in a heated mold.

Petroleum products and energy resources play a vital part in tire manufacture. The polymers are principally manufactured from petroleum and the most important textiles, nylon and polyester, are also petroleum based. Heat is required to cure the polymers, and significant amounts of electrical power are involved in masticating and other process activities. During tire manufacture, a large proportion of value is added to the original petroleum, so that a pound of tire represents a market value two orders of magnitude greater than the cost of its crude petroleum source materials.

1.2 Task II, Industry Output

Exhibit VIII-4 presents value of shipments for milestone years including 1967, 1971, 1973, and 1974 projected. The total value of products and services sold by SIC 3011 industry in 1973 was about $6,500 million.

Exhibits VIII-5 and 6 provide similar data for numbers of tires both in absolute magnitude and equivalent passenger car tires. In 1973 approximately 364 million equivalent tires were produced.

- 189 million passenger tires
- 87 truck and bus tires
- 36 million other tires, tubes, etc.

Based on these data, Exhibit VIII-2-1, Required Table 1, was prepared.

1.3 Task III, Energy Related Profile of Major Processes

The energy consuming operations performed in the SIC 3011 industry fall essentially into one of three classes: mastication, calendering, vulcanization.

The energy requirements of mastication are fairly constant from one type of stock to the other.

Calendering is used to produce the thin sheet of uncured rubber which can be used by itself (as for instance, an inner tube) or applied to a fiber substrate. The energy requirement of extrusion (which in the rubber industry is referred to as "tubing") are approximately equivalent, pound for pound to those of calendering.

Vulcanization is the curing process. Essentially, the energy is used to keep the equipment at the proper temperature, and on a pound basis products are also approximately equivalent. Therefore, no attempt was made to subdivide energy requirements.

The energy required to manufacture each radial passenger tire is somewhat higher than that required to produce the traditional passenger tires.

1.4 Task IV, Shifts in the Energy Related Profile of the Industry - 1971 to 1973

Exhibit VIII-7 presents energy factors for the tire industry based on 1967 and 1971 census data and Snell estimates. The factors show a trend away from coal toward the use of fuel oil. Based on these data, the following changes are seen in the fuel and energy BTU requirements of the equivalent passenger tire.

Year	Average Fuel and Energy Requirement For The Equivalent Passenger Car Tire From Census Data
1967	260,000 BTU
1971	290,000 BTU
1973	290,000 BTU

A leading tire producer reported an approximate fuel and energy requirement of 250,000 BTUs per equivalent tire. This probably represents efficient manufacturing practice.

It is seen from the table above that the trend in the industry average fuel and energy requirement per equivalent unit of production has been toward increased requirement of heat and power input per equivalent tire from 1967 to 1971. This is principally accounted for by the increased use of electricity, seen in Exhibit VIII-7.

At the industry level there has been an approximately 0.3% increase in the fuel and energy BTU needs of the industry between 1971 and 1973, from 105,500 billion BTU to 105,800 billion BTU, shown in Exhibit VIII-2-5, Required Table 5. Since 1967 there have been major fuel shifts in the industry, reflecting increased dependence on petroleum based fuels. Assuming continuation of this trend, between 1971 and 1973 there was a 2,800 billion BTU (26%) increase in the use of oil, a 4,800 billion (16%) increase in the use of natural gas; these offset the 7,300 billion BTU (34%) decrease in the use of coal during the same period.

1.5 Task V, Projected 1974 Energy Related Profile of the Industry

In projecting 1974 fuel and energy use by the tire industry, no change in the 1973 energy factor is assumed. Reasons include stoppage and possibly reversal of the shift from coal to oil usage, and the offsetting of gains from conservation efforts by the rapid shift toward the manufacture of radial tires. Steel-belted, radial-ply tires are expected to increase their share of the original equipment market from 18% in 1973 to 45% in 1974; in the replacement market this is expected to be from 14% to 20%, respectively.

Exhibit VIII-2-5 indicates a 9% increase in the fuel and energy needs of the industry from 1973 to 1974. This is based upon Snell estimates of 1974 tire production shown in Exhibit VIII-5 which are designed to hold tire inventories constant.

2. GEOGRAPHIC PATTERN OF USE

The principal outputs from the tasks of this sub-section are "Required Tables" and analysis of findings.

2.1 Task I, Geographic Pattern of the Industry's Energy Related Profile - 1971 to 1973

Census data does not define state-by-state distribution of each category of purchased fuels at the four digit SIC level. However, meaningful estimates of the fuel and energy BTUs consumed in several states have been made. This information is presented in Exhibit VIII-2-8 as Required Table 8 along with an explanation of the methodology employed. Based on this data, Exhibits VIII-2-6 and 7, Required Tables 6 and 7, have been developed using the national breakdown of energy consumption among the various fuels from Exhibit VIII-2-5.

The fuel and energy requirement of the industry increased only slightly from 1971 to 1973. This was probably due to the relatively low production levels (compared to quantities shipped) achieved in 1973. The BTU requirements of states in the South Central region increased at a significant rate. The BTU needs of Tennessee, Alabama, Arkansas, Oklahoma and Texas increased by 11,600 billion BTUs, accounting for about 57% increase between these two years whereas total industry energy consumption was essentially unchanged.

The primary area for industry growth in recent years appears to have been the South Central region both in terms of percentage and absolute growth rates.

Ohio is by far the greatest consumer of energy in the production of tires and inner tubes accounting for 2-1/2 times the consumption of the second most important state and about 25% of all fuel and energy consumed by the SIC 3011 industry in 1973.

2.2 Task II, Geographic Pattern of Employment and Shipments

The Bureau of Labor Statistics (BLS) reports 1971 employment in SIC 3011 industry of 121.8 thousand, while in 1973 this was 136.6 thousand. The "County Business Patterns" (CBP) reports 1971 employment in SIC 3011 industry of 93,580 thousand. Since more state level data is provided by CBP than by BLS, the former is used to show regional distribution in Exhibit VIII-2-8, Required Table 8.

Employment distribution serves as the basis for estimating geographic distribution of

- value of shipments for 1971 for geographic units for which the "Annual Survey of Manufactures - 1971" provides no data
- value of shipments for 1973
- fuels and energy BTUs for 1971 and 1973

In 1973, Ohio accounted for more than 20% of SIC 3011 industry employment and shipments.

2.3 Task III, Shifts in the Patterns

The following are observations regarding the geographic distribution of the value of shipments:

- In 1971 the East North Central region accounted for about 37% of the national value of shipments and Ohio was the most important state accounting for about 25% of the national value. From 1971 to 1973 value of shipments increased in the state at a 3% rate, considerably below the 24% national average.
- Industry growth appears to be concentrated in the South Central region.

Employment in the industry rose by about 12% from 1971 to 1973 with below industry average gain in Ohio and no gain in Michigan. The rate of growth was dramatic in the South Central region.

3. FUEL AND ENERGY SUPPLY SITUATION

The principal outputs from the tasks of this sub-section are "Required Tables" and analysis of findings. These findings were developed from industry interviews and review of in-house information.

3.1 Task I, "Normal" Stocks of Materials

Over the past decade, changing national defense strategic material stockpile philosophy has combined with the continued growth of the national economy and more sophisticated inventory management techniques to reduce tire materials stocks from the one-year level to the two-month level, as a "normal" inventory objective for tire polymers and textiles.

3.2 Task II, Shifts in Stocks

Difficulties in petroleum feedstocks and manufacture of polymers and textiles has caused significant dislocations in materials stocks. Industry-wide allocations of material at approximately 80% of 1972 levels, coupled with continued high rates of tire production, have drawn end of 1973 materials inventories below the one-month level.

Fuels inventories have decreased proportionately with national average fuel inventory decreases and a rough indication is provided in Exhibit VIII-2-9, Required Table 9.

3.3 Task III, Captive Use

This industry possesses partial captive capacity in polymers and textiles, as well as in electric power production. Its electric power captive capacity is usually tied to major utilization of exhaust steam for process heating, providing outstandingly efficient utilization of energy. During 1973 about 500 million KWH of electricity were captively generated. Required Table 10 is not presented.

3.4 Task IV, Sources of Supply

The concentrated nature of this industry generally results in stable and sophisticated supplier relationships.

The smaller entities in this industry are not as able to influence their sources of supply as the larger entities. Nevertheless, even a small tire company is a large operation and represents a valuable outlet to potential materials suppliers.

3.5 Task V, Proportion by Type of Supplier

The proportion of the industry's fuel and energy requirements provided by each type of supplier is not available and Required Table 11 is not presented. Generally only large suppliers provide the major needs of tire companies.

3.6 Task VI, Seasonality of Use

Average usage of materials and total energy is relatively uniform. There are some seasonal fluctuations in energy usage. For example, electrical energy usage is greater in the summer when it is needed for process cooling and air conditioning. Process heating (whether derived from coal, oil, or gas) and plant heating is somewhat greater in the winter than in the summer.

Exhibit VIII-2-12, Required Table 12, provides rough quantification of seasonality.

4. SUBSTITUTABILTY AND CONSERVATION OF MAJOR FUELS AND PETROLEUM PRODUCTS

The findings under this section were developed through interviews with industry sources, Snell staff expertise, review of secondary sources and review of in-house information.

4.1 Task I, Major Processes

The U.S. Department of Transportation regulations such as FMVSS 109 and other tire safety and quality requirements, coupled with accepted industry quality-assurance procedures, establish a minimum leadtime of approximately 18 months to qualify any significant change in tire materials, or construction. This makes it virtually impossible for materials substitutions to be introduced in 1974, since no major substitutions are presently in the approval cycle.

The Uniform Tire Quality Grading System, now required by statute, may be introduced by U.S. Department of Transportation during 1974. This will require major product testing steps, above the present manufacturers' quality and safety testing levels, further reducing flexibility in materials substitutions and process changes.

Additional plant housekeeping efforts, such as locking thermostats, etc., already in industry-wide effect tend to conserve energy. It is estimated that these savings can be of the order of 5% of process and other plant energy requirements.

Substitutability of coal for oil and gas fuels is under serious consideration in the larger companies. The major shift from the use of coal to the use of natural gas and oil in recent years was principally motivated by air pollution control requirements.

4.2 Task II, Quantification of the Major Substitutability and Conservation Opportunities

Roughly 55% of the industry's fuel and electricity BTU requirements are supplied by purchased electricity and coal. An appreciable opportunity exists to replace natural gas or oil with coal.

- About 4 barrels of oil can be saved by each ton of coal substituted.

- Substitution of coal for oil and natural gas to bring the relative consumptions of these fuels back to 1971 proportions would reduce the annual consumption of oil and natural gas by 525,000 barrels and 5 billion cubic feet, respectively, in 1974.

- Such substitution, in turn, would require an additional 330,000 short tons of coal.

Back conversion from oil or gas to coal burning can be engineered in 2-3 months in facilities originally designed for coal. Environmental approval for such action would probably require a longer period. Facilities designed to burn oil or gas need to be replaced by new coal facilities requiring two years or more from design to approval and startup.

In cases where environmental approval can be obtained without addition of pollution control equipment, the following are some engineering and economic considerations regarding the change to coal burning in steam generators in the 100,000 lbs steam per hour range:

- Back conversion to coal of a boiler designed for coal but burning oil or gas would cost $1 to $8 per lb steam per hour, depending on the condition of the retired coal features.

- A replacement coal burning facility would cost $15 to $20 per lb steam per hour.

Should sophisticated particulate and sulfur control equipment be required, an additional cost of up to $15 to $20 per lb of steam per hour would be incurred. The operating costs of this equipment may be as high as $10 per ton of coal burned.

4.3 Task III, Principal Constraints

Significant shifts back to coal are constrained by the capital costs of coal burning facilities, since oil or gas fired units not designed originally for coal use have to be essentially replaced. The capital cost of a coal facility can be five times that of an oil or gas unit, not considering the additional anti-pollution control equipment. Back conversion from oil or gas to coal of a facility originally designed to fire coal can cost up to one half that of a new coal unit.

Environmental concerns with air pollution from coal burning steam generators is a second principal constraint. If long term air pollution codes are eased, the industry is expected to be willing to provide the major capital investment to increase the use of coal significantly.

4.4 Task IV, Plant Level Operating Characteristics

This industry is so large and concentrated that production levels can be increased and decreased by the opening or closing of economically viable production units. Therefore, the energy and materials impact is essentially continuous, without showing major breakpoints in operating efficiency as production schedules increase or decrease.

4.5 Task V, Capital Stock (1973)

The 1973 gross book value of fixed assets is about $3.5 billion. This estimate is based on the following:

- The 1971 "Annual Survey of Manufactures" indicates that the gross book value of fixed assets was $2,827 million in 1971.
- According to the same source, capital expenditures in 1972 were $296 million.
- It is assumed that the major portion of capital expenditures in the last 2-3 years has been spent on radial tire production capacity and some expansion of truck and bus tire production equipment and that the retirement of equipment designed for the production of bias and bias-belted tires has been minimal.
- If it is assumed that the increased production of radial, truck and bus tires in 1973 reflects increased capacity, the capital cost of production equipment would be around $15 per equivalent tire produced.
- Based on these figures and the increased market penetration of radial tires in 1974, 1973 capital expenditures are estimated at about $400 million.

- Considering minimal retirement of SIC 3011 industry capital assets, the net increase in gross capital assets from the end of 1971 to 1973 is estimated at close to $700 million.

The present cost of a tire facility is estimated to be about $15 per equivalent passenger car tire of production capacity. Assuming the minimum expected 1974 production of SIC 3011 industry of 383 million equivalent units represents 85% of end-of-year 1973 production capacity, the replacement value of present production capacity is in excess of $7 billion.

4.6 Task VI, Planned Capital Investment (1974)

Using the same assumptions as in Task V above, the planned capital investment in 1974 is estimated at $450-$500 million.

- The production of radial tires in 1975 is expected to require increased production capacity for more than 20 million tires.
- With a continued expansion in the market for truck and bus tires, total additional equivalent passenger car tire production capacity is estimated at 30 million units requiring capital expenditures of $450 million in current dollars.

4.7 Task VII, Changes to Investment Plans

Industry interviews indicate no changes in short-term level of capital investment in the tire and inner tube industry. Any decrease in capital expenditures for the modification of coal burning equipment to oil or gas may be offset by the expenditures necessary for a reversion to coal usage. Furthermore, a continued slowdown in the purchase of new automobiles would most likely be offset by an increase in the replacement and bus tire markets.

5. INTRA-INDUSTRY EFFICIENCY

The findings in this section have been developed through interviews with industry sources, an analysis of industry and in-house data, and Snell expertise in this area.

5.1 Task I, Energy Efficiency

Among the five major tire producers accounting for most of the industry's shipments, there are probably appreciable variations in energy efficiency. This is a function of plant design, age and operations. This is probably $\pm$ 20% or more of the industry average.

5.2 Task II, Major Factors Affecting Efficiency

The rapid move to the production of radial tires essentially constitutes a major modernization of the industry. It is expected that the new radial facilities will be designed and operated with maximum consideration of energy efficiency.

6. PRINCIPAL CONSTRAINTS ON CURRENT INDUSTRY OPERATIONS

The findings presented in this section have been obtained through interviews with industry sources, and through the study of secondary sources and in-house information.

6.1 Task I, Important Constraints

On the supply side, the potential constraints on industry output include fuels, energy and raw materials availability and cost and production capacity. Industry interviews indicate that fuel and energy availability was not a principal constraint during 1973 and the first quarter of 1974. If availability is reduced, rapid substitution of coal for other fuels is not possible. Petroleum-based raw material shortages have been of concern both in regard to availability and cost. Conservation opportunities are minimal in regard to fuels, energy and raw materials. The latter is constrained by DOT regulation on tire safety and quality. Raw materials consumption is directly related to level of output. Plant capacity for the traditional products of the industry is not a principal constraint. The industry is responding rapidly with new construction to the rising demand for radial tires.

On the demand side, the potential principal constraints on the industry's output include:

- demand for new automobiles
- gas shortages, speed limit reductions and reduced vehicle miles traveled
- shift to smaller cars
- demand for the longer lived radial tires
- demand in industrial sectors
- price increases

6.2 Task II, Most Serious Constraint

The most serious constraint on industry output is probably on the demand side.

The interaction of the demand factors listed under 6.1 is complex. It is concluded that general economic conditions resulting in variations in the magnitude of these factors are the principal constraint. During 1974 these variations are not likely to cause "bottlenecks" in the supply of the industry products.

6.3 Task III, Shortfall in Supply and Price Increases

In 1974, no shortfall in supply in relation to demand is expected. Although raw materials and fuels will probably be more expensive and not as readily available as in past years, the supply of these inputs to the industry should be sufficient to enable meeting the demand for tires and inner tubes.

Industry price increases are expected to be to a significant extent, the result of increases in the costs of raw materials.

Tire prices at wholesale have risen about 10% during the last quarter of 1973 and the first quarter of 1974. The Cost of Living Council granted the industry 3% increments in October, 1973 and in January, 1974. On January 31 all price controls were removed, although increases were held to 5% through July. On August 1, prices can be set freely.

SIC 3011 price increases are not expected to have the same magnitude of effect on the demand for industry products as other factors affecting demand, discussed in Task I above. Price increases probably will have no major effect on industry output.

The industry is highly unionized. There does not appear to be an appreciable opportunity to offset increased production costs through a reduction in employment.

6.4 Task IV, Outputs Critical to Subsequent Production

Tires are vital to the U.S. transportation business which in turn is important to nearly all production. The table below illustrates the impact of the tire industry on sectors of the economy

Sector	Tire Value per $1000 of Expenditure	Total Value ($ Millions)
Personal Consumption	$ 3.11	$2540
Other Final Demand		459
Motor Vehicles	18.00	1200
Auto Repair	17.79	420
Trucking	10.14	297
Farm Machinery	21.00	118
Coal Mining	10.81	62
Other Intermediate		1971
Total Output		$7067

Source: Rubber and Plastics News, September 24, 1973.

EXHIBIT VIII-1
FEO: USDC
DEFINITION OF SIC 3011[1]

SIC 3011 TIRES AND INNER TUBES

Establishments primarily engaged in manufacturing pneumatic casings, inner tubes, and solid and cushion tires for all types of vehicles, airplanes, farm equipment, and children's vehicles; tiring; and camelback, and tire repair and retreading materials. Establishments primarily engaged in retreading tires are classified in Industry 7534.

Camelback for tire retreading
Inner tubes; airplane, automobile, bicycle, motorcycle, and tractor
Pneumatic casings (rubber tires)
Tire sundries and tire repair materials, rubber
Tires, cushion or solid rubber
Tiring, continuous lengths: rubber, with or without metal core

Source: 1972 Standard Industrial Classification Manual

(1) The 1972 SIC definition is the same as that used in the 1967 census.

EXHIBIT VIII-2-1
FEO:USDC
REQUIRED TABLE 1

Proportion of Industry Output Accounted for by Each Major Process, 1973

SIC 3011 Industry Tires and Inner Tubes

Process and Major Products	Percent of 1973 Shipments Value	Percent of 1973 Production Volume 1/
Passenger car tires	51.7%	51.8%
Truck and bus tires	24.0	23.8
Other tires, tubes, tread rubber, etc.	10.0	10.0
Secondary products and miscellaneous receipts	14.3	14.4
Total Industry (Percent)	100.0	100.0
(Actual)	$6,500,000,000	364,000,000

1/ Production volume expressed in equivalent passenger car tires.

Source: Exhibits VIII-4, VIII-5, and VIII-6.

EXHIBIT VIII-2-5
FEO: USDC
REQUIRED TABLE 5

Industry Consumption of Fuels, Petroleum Products, and Energy by Type - 1971, 1973, and 1974

SIC 3011 Industry Tires and Inner Tubes

Line No.	Type of Energy or Material	Unit of Measure	Volume(1) 1971	Volume(1) 1973	Volume(1) 1974	Bil. BTUs(2) 1971	Bil. BTUs(2) 1973	Bil. BTUs(2) 1974	% Change 1971-73	% Change 1973-74	% of Total BTUs 1971	% of Total BTUs 1974
1	Propane, butane, and mixtures											
2	Middle distillates	1,000 barrels	1,221	1,638	1,787	7,100	9,500	10,400	33.8	9.5	6.7	8.9
3	Residual fuel oil	1,000 barrels	549	619	675	3,500	3,900	4,200	11.4	7.7	3.3	3.7
4	Chemical feedstocks											
5	Other petroleum, products, total											
6	Petroleum products, total											
7	Coal	1,000 short tons	824	546	596	21,600	14,300	15,600	(33.8)	9.1	20.4	13.5
8	Natural gas	billion cu. ft.	28.9	33.5	36.5	29,800	34,600	37,600	16.1	8.6	28.2	32.7
9	Fuels, n.e.c. total											
10	Other fuels, total											
11	Electrical energy (purchased only)	million KWH	4,100	4,100	4,490	43,500	43,500	47,600	(Z)	9.4	41.2	41.1
12	GRAND TOTAL		(X)	(X)	(X)	105,500	105,800	115,400	0.3	9.1	100%	100%

Source: (1) Estimates are based on the energy factors of Exhibit VIII-7 applied to the total equivalent passenger car tire production figures of Line 1, Exhibit VIII-5. For 1974 the 1973 energy factor and the average of the "High" and "Low" production figures were used.
(2) BTUs and Cu. Ft. of natural gas have been changed to billions from millions.

EXHIBIT VIII-2-6a
FEO:USDC
REQUIRED TABLE 6

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit

SIC 3011 Industry Tires and Inner Tubes (1) Year 1971

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Petroleum Products: Distillates (Thousand Barrels)	Petroleum Products: Residual (Thousand Barrels)	Petroleum Products: Feedstocks (Thousand Barrels)	Petroleum Products: Other (Thousand Barrels)	Petroleum Products: Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Other Fuels: Natural Gas (Bil. Cu. Ft.)*	Other Fuels: Fuels, n.e.c. (Bil. BTU s)*	Other Fuels: Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
1	United States	(X)	1,221	549	(X)	(X)	10,600	824	28.9		51,400	43,500	105,500
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.		35.3	16.1			310	24	0.8		1,500	1,260	3,070
8	R.I.												
9	Conn.												
10	Middle Atlantic												
11	N.Y.												
12	N.J.												
13	Penn.		91	41.4			790	62.5	2.2		3,860	3,240	7,890
14	NORTH CENTRAL												
15	E. North Central		456	208			3,970	314	10.8		19,400	16,300	39,700
16	Ohio		296	135			2,580	204	7.0		12,600	10,600	25,800
17	Ind.												
18	Ill.												
19	Mich.		83	38			720	57	2.0		3,540	2,980	7,240
20	Wisc.												
21	W. North Central		102	46			890	70	2.4		4,360	3,670	8,910
22	Minn.												
23	Iowa												
24	Mis.												
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.
(1) State and regional BTUs from Exhibit VIII-2-8 were distributed by fuel and energy type according to the national pattern. See Exhibit VIII-2-8 for those states and regions for which estimates are not available

EXHIBIT VIII-2-6 b

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic		103	47			900	71	2.5		4,410	3,200	9,000
31	Del.												
32	Md.												
33	D.C.												
34	Va.												
35	W. Va.												
36	N.C.												
37	S. C.												
38	Ga.												
39	Fla.												
40	S.Central		289	131			2,510	199	6.9		13,300	10,300	25,100
41	Ky												
42	Tenn.		63	29			550	43	1.5		2,690	2,260	5,490
43	Ala.		80	37			700	55	1.9		3,420	2,870	6,980
44	Miss.												
45	Ark.		16	7			140	11	0.4		700	590	1,430
46	La.												
47	Okla.		33	15			290	2.3	0.8		1,420	1,190	2,890
48	Texas		40	18			350	28	1.0		1,710	1,440	3,500
49	WEST		101	46			880	69	2.4		4,290	3,600	8,770
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT VIII-2-6c

		Petroleum Products						Other Fuels					
Line Number	Geographic Unit	Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
59.	Pacific		101	46			880	69	2.4		4,290	3,600	8,770
60	Wash.												
61	Ore.												
62	Cal.		101	46			880	69	2.4		4,290	3,600	8,770
63	Alas.												
64	Haw.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT VIII-2-7a
FEO:USDC
REQUIRED TABLE 7

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit

SIC 3011 Industry Tires and Inner Tubes(1) Year 1973

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s) *	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTUs)*	Purchased Electrical Energy (Bil. BTUs)*	Grand Total (Bil. BTUs)*
1	United States		1,638	619			13,400	546	33.5		48,900	43,500	105,800
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.												
8	R.I.												
9	Conn.												
10	Middle Atlantic												
11	N.Y.												
12	N.J.												
13	Penn.		176	67			1,450	58	3.6		5,260	4,710	11,450
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio		435	166			3,510	146	9.0		13,080	11,600	28,300
17	Ind.												
18	Ill.												
19	Mich.		120	46			980	40	2.5		3,600	3,200	7,780
20	Wisc.												
21	W. North Central												
22	Minn.												
23	Iowa												
24	Mis.												
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Source: (1) State and regional BTUs from Exhibit VIII-2-8 were distributed by fuel and energy type according to the national pattern. See Exhibit VIII-2-8 for these states and regions for which estimates are not available.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.												
33	D.C.												
34	Va.												
35	W. Va.												
36	N.C.												
37	S. C.												
38	Ga.												
39	Fla.												
40	S.Central												
41	Ky		126	48			1,040	179	2.6		3,790	3,380	8,210
42	Tenn.		172	66			1,420	244	3.6		5,190	4,620	11,200
43	Ala.												
44	Miss.		30	11			250	42	0.6		900	800	1,940
45	Ark.												
46	La.		83	32			680	28	1.7		2,500	2,200	5,400
47	Okla.		80	30			660	27	1.6		2,400	2,100	5,190
48	Texas		170	65			1,390	57	3.5		5,098	4,500	11,000
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.												
33	D.C.												
34	Va.												
35	W. Va.												
36	N.C.												
37	S. C.												
38	Ga.												
39	Fla.												
40	S.Central												
41	Ky		126	48			1,040	179	2.6		3,790	3,380	8,210
42	Tenn.		172	66			1,420	244	3.6		5,190	4,620	11,200
43	Ala.												
44	Miss.		30	11			250	42	0.6		900	800	1,940
45	Ark.												
46	La.		83	32			680	28	1.7		2,500	2,200	5,400
47	Okla.		80	30			660	27	1.6		2,400	2,100	5,190
48	Texas		170	65			1,390	57	3.5		5,093	4,500	11,000
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT VIII-2-7c

		Petroleum Products						Other Fuels					
Line Number	Geographic Unit	Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil.BTUs)*
59	Pacific		170	65			1,390	57	3.5		5,090	4,500	11,000
60	Wash.												
61	Ore.												
62	Cal.		170	65			1,390	57	3.5		5,090	4,500	11,000
63	Alas.												
64	Haw.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT VIII-2-8 a
FEO:USDC
REQUIRED TABLE 8

Shipments, Employment, and Fuels and Energy Consumed by Geographic Unit, 1971 and 1973

SIC 3011 Industry Tires and Inner Tubes

Line Number	Geographic Unit	Value of Shipments ($ Millions) 1971 (7,8)	1973 (9)	% Change	Employment 1971 (1)	1973	% Change (6)	Fuels and Energy (10) (Bil. BTU s)* 1971	1973	% Change
1	United States	5,232	6,500	24	93,580 (2)	104,950 (3,4,5)	12	105,500	105,800	0.3
2	NORTH EAST	(NA)								
3	New England	(NA)								
4	Maine	(NA)								
5	N.H.									
6	Vermont									
7	Mass.	153	(NA)		2,748	(NA)		3,070	(NA)	
8	R.I.									
9	Conn.	(NA)								
10	Middle Atlantic	(NA)								
11	N.Y.	(NA)								
12	N.J.	(NA)								
13	Penn.	392	530	35	7,012	8,500	21	7,890	11,450	45
14	NORTH CENTRAL	(NA)								
15	E. North Central	1,972	(NA)					39,700	(NA)	
16	Ohio	1,279	1,310	2	20,705	21,180	2	25,800	28,300	9.7
17	Ind.	(NA)								
18	Ill.	(NA)								
19	Mich.	326	360	10	5,838	5,840	0	7,240	7,780	7.5
20	Wisc.	(NA)								
21	W. North Central	443	(NA)					8,910	(NA)	
22	Minn.	(NA)								
23	Iowa	(NA)								
24	Mis.	(NA)								
25	N.D.									
26	S.D.									
27	Neb.									
28	Kans.									

* BTU s and Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

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Line Number	Geographic Unit	Value of Shipments ($ Millions)			Employment			Fuels and Energy (Bil. BTU s)*		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
29	SOUTH	(NA)								
30	S. Atlantic	454	(NA)					9,000	(NA)	
31	Del.									
32	Md.	(NA)								
33	D.C.									
34	Va.	(NA)								
35	W. Va.									
36	N.C.	(NA)								
37	S.C.									
38	Ga.	(NA)								
39	Fla.	(NA)								
40	S. Central	249	(NA)					25,100	(NA)	
41	Ky.	(NA)								
42	Tenn.	273	380	39	4,891	6,150	26	5,490	8,210	49.5
43	Ala.	347	520	49	6,641	8,340	26	6,980	11,200	60.5
44	Miss.	(NA)								
45	Ark.	71	90	26	1,273	1,450	14	1,430	1,940	35.6
46	La.	(NA)								
47	Okla.	144	250	71	2,580	3,980	54	2,890	5,400	86.9
48	Texas	174	240	36	2,999	3,820	27	3,500	5,180	48.0
49	WEST	436	510	17	7,808	8,260	6	8,770	11,000	25.4
50	Mountain									
51	Mont.									
52	Idaho									
53	Wyo.									
54	Colo.									
55	N.M.									
56	Ariz.									
57	Utah									
58	Nev.									

EXHIBIT VIII-2-8c

Line Number	Geographic Unit	Value of Shipments ($ Millions)			Employment			Fuels and Energy (Bil. BTU s)*		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
59	Pacific	436	510	17	7,808	8,260	6	8,770	11,000	25.4
60	Wash.									
61	Ore.									
62	Cal.	436	510	17	7,808	8,260	6	8,770	11,000	25.4
63	Alas.									
64	Haw.									

Source: (1) County Business Patterns (CBP), 1971.
(2) 121.8 thousand according to the Bureau of Labor Statistics (BLS).
(3) 136.6 thousand according to BLS.
(4) 1971 CBP data times ratio of (3)/(2) above.
(5) 1972 CBP employment was 100,071; thus the change from 1972 to 1973 was 4.9%.
(6) Percent change estimated for states assuming continuation through 1973 of the trend from 1971 to 1972, except for U.S. total and except for Oklahoma, where industry average change from 1972 to 1973 of 4.9% was assumed.
(7) Lines 1, 18, 16, 21, 30, 40, 43 and 48 from "Annual Survey of Manufactures," M71 (AS)-1 and M71 (AS) 6.1 through 6.9.
(8) Lines 7, 19, 42, 45, 47 and 62 from Line 1 "Value of Shipments" divided by Line 1 "Employment" multiplied by employment in these lines.
(9) Line 1 from Exhibit VIII-4 and remaining lines using procedure of (8) above.
(10) Line 12 from Exhibit VIII-2-5 and remaining lines estimated by determining the pounds of production represented by each regional value of shipment and applying the energy factor of "BTU Equivalents of Fuels and Purchased Electricity" from Exhibit VIII-7.

EXHIBIT VIII-2-9
FEO: USDC
REQUIRED TABLE 9

Stocks of Fuels and Petroleum Products by Type, 12/31/73 and 3/31/74

SIC 3011 Industry Tires and Inner Tubes

Line Number	Type of Energy or Material	Stocks[1] (# of days supply related to average daily requirements in next quarter) As of December 31 1971	1972	1973	As of March 31 1972	1973	1974
1	Propane						
2	Butane						
3	Propane Butane Mixture						
4	Middle Distillates	30	30	30	15	15	15
5	Residual Fuel Oil	30	30	30	15	15	15
6	Chemical Feedstocks						
7	Other Petroleum Products, total						
8	Coal	90	90	90	60	60	60
9	Natural Gas [2]	(X)	(X)	(X)	(X)	(X)	(X)
10	Fuels, n.e.c., total						

(1) Illustrative but statistically not meaningful values obtained from industry interviews.
(2) Pipeline gas sometimes interruptable during winter months.

EXHIBIT VIII-2-12
FEO: USDC
REQUIRED TABLE 12

Seasonal Use of Fuels, Petroleum Products and Energy by Type, 1973

SIC 3011 Industry Tires and Inner Tubes

Line Number	Type of Material or Energy	Percent of Annual Use in 1973 in Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.
1	Propane, butanes and mixtures				
2	Distillates				
3	Residual	30	25	20	25
4	Feedstocks				
5	Other petroleum products				
6	Coal	30	25	20	25
7	Natural gas	30	25	20	25
8	Other fuels				
9	Electrical Energy (purchased)	20	25	30	25

Source: Industry interviews and Snell estimates.

EXHIBIT VIII-3(1)
Federal Energy Office: U.S.
Department of Commerce
PRODUCTION SYSTEM FLOW DIAGRAM
BIAS AND BIAS BELTED TIRES

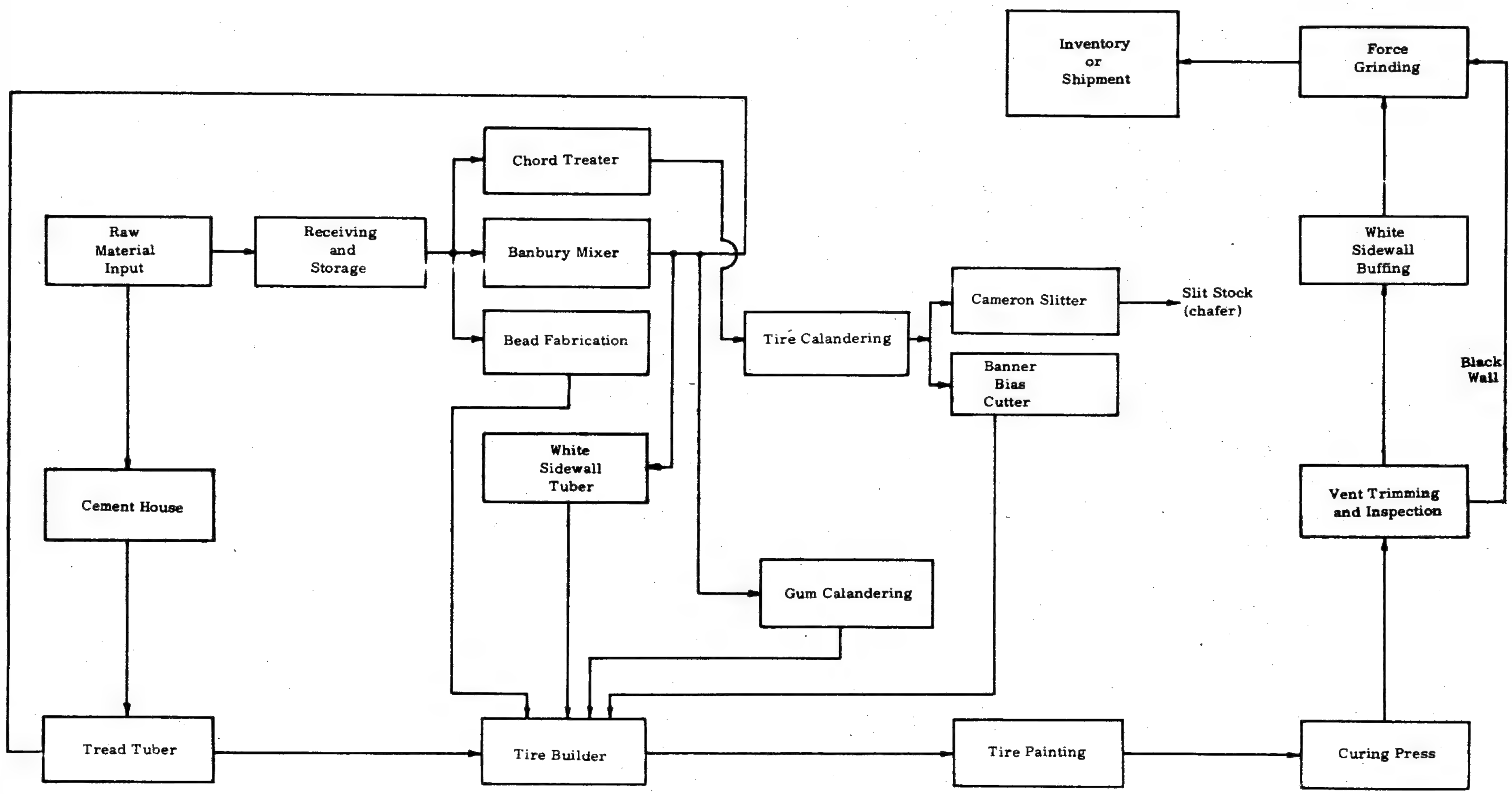

EXHIBIT VIII-3(2)
Federal Energy Office: U.S.
Department of Commerce
PRODUCTION SYSTEM FLOW DIAGRAM
RADIAL TIRES

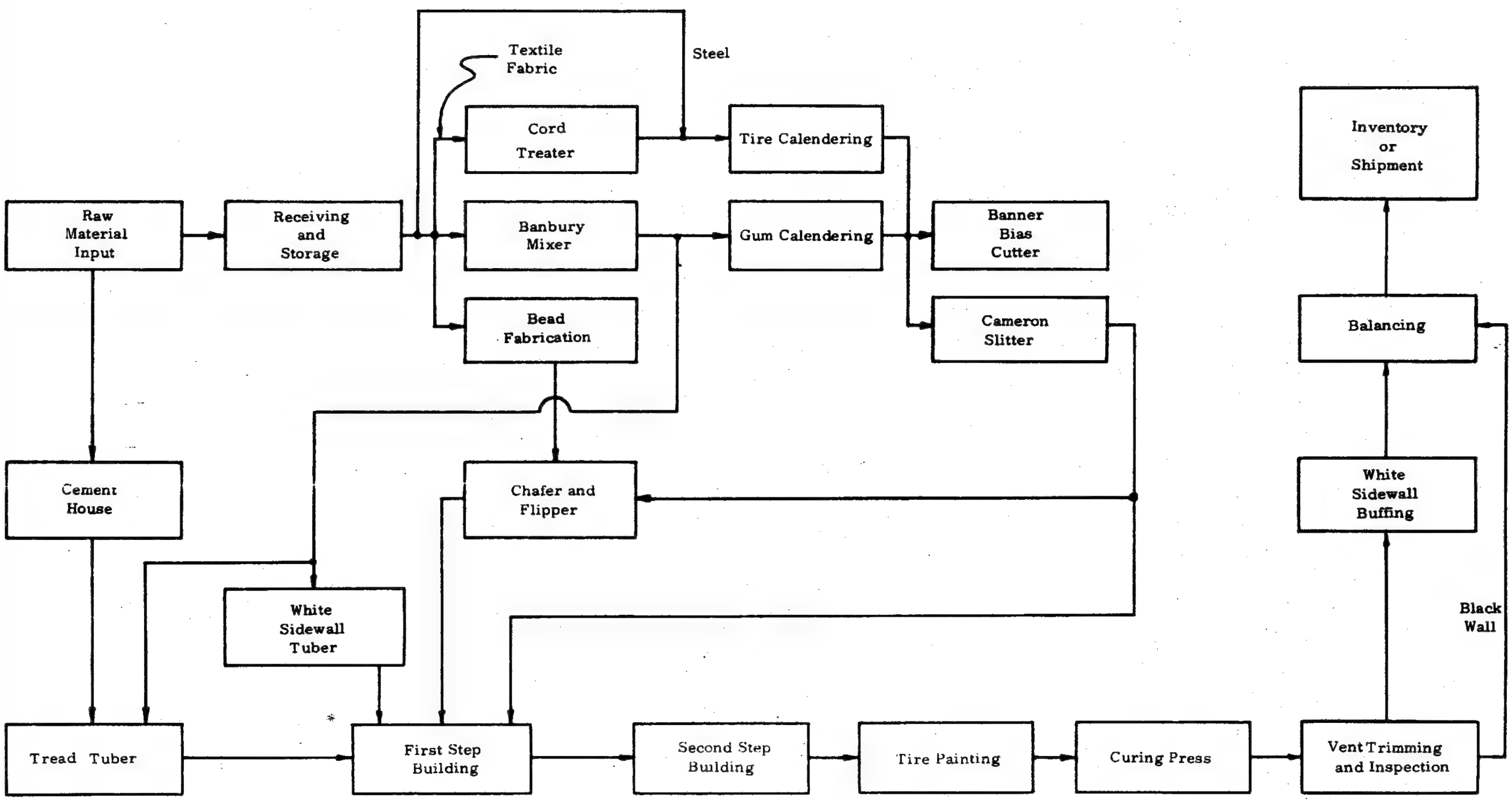

EXHIBIT VIII-3(3)
Federal Energy Office: U.S. Department of Commerce
PRODUCTION SYSTEM FLOW DIAGRAM
LIGHT TRUCK AND TRUCK AND BUS TIRES

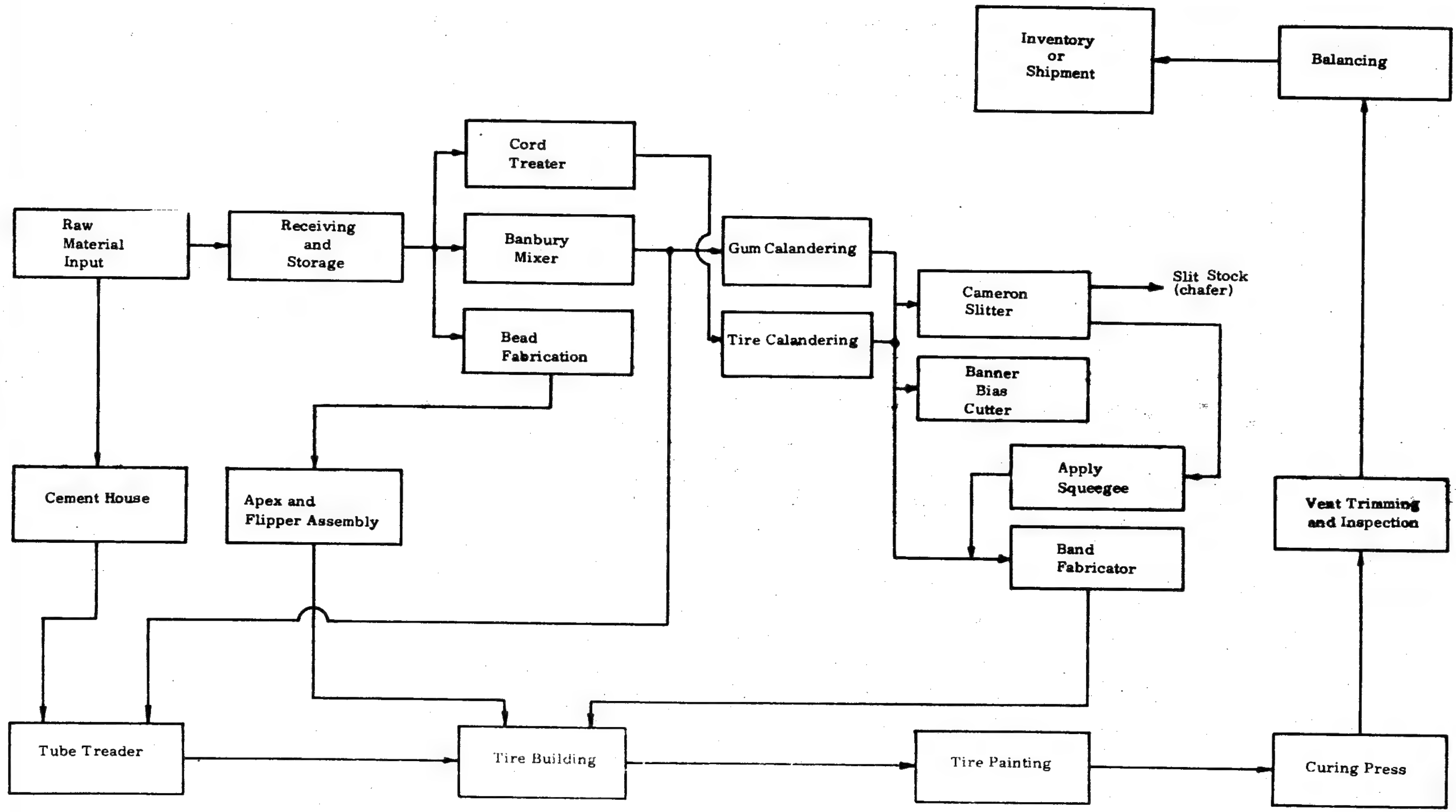

EXHIBIT VIII-4
FEO: USDC
SIC 3011 - VALUE OF SHIPMENTS - 1967, 1971-1974
(Dollars in Millions)

LINE	ITEM	1967	1971	1972	1973	1974 (6) Low	1974 (6) High
1.	Total value of products and services sold by SIC 3011 industry (1)	$3,733.9	$5,231.9	$5,824	$6,500	$7,340	$7,899
2.	Value of SIC 3011 products shipped by SIC 3011 industry (2)	3,103.4	4,439.2	4,976	5,566	6,285	6,764
3.	Value of SIC 3011 products shipped by all industries (3)	3,133.5	4,471.2	5,008	5,600	6,323	6,805
4.	Ratio of value of SIC 3011 products shipped by SIC 3011 industry to value of SIC 3011 products shipped by all industries (coverage ratio) (4)	0.99	0.99	0.99	0.99	0.99	0.99
5.	Value of major SIC 3011 products shipped by SIC 3011 industry: (5)						
	Passenger car tires	$1,713.0	$2,680.7	$3,033	$3,359	$3,760	$4,003
	Truck and bus tires	828.8	1,169.1	1,371	1,558	1,792	1,972
	Other tires, tubes, tread rubber, etc.	561.6	589.4	572	649	733	789

Footnotes:

(1) Figures for 1967, 1971, and 1972 from Sources (a)-(c). Figure for 1973 from Source (d).

(2) Figure for 1967 from Source (a). Figures for 1971-1973 are sums of values for product categories in line 5.

(3) Figures for 1967 and 1971 from Sources (a) and (b). Figures for 1972 and 1973 obtained from data in Sources (c) and (d) modified according to information obtained from Source (e).

(4) Ratio for 1967 is that established in Source (a). Ratios for 1971-1974 obtained from the division of line 2 by line 3.

(5) Figures for 1967 obtained from data in Source (a). Figures for 1971-1973 obtained by multiplying total shipment by all industries data from Sources (b), (d), and (e) by individual coverage ratios for the three major product groups established from 1967 data.

(6) High/Low for three major product groups obtained using following assumptions (See also Source (f)):

	Low	High
Quantity of Shipments:		
Passenger tires (original equipment)	down 10% from '73	same as in '73
Passenger tires (replacement)	same as in '73	up 5% from '73
Truck and bus tires	same as in '73	up 10% from '73
Prices	up 15% from '73	up 15% from '73

Value of shipments of "other" category estimated to range from low to high percentage increases in 1974 total value of shipments of passenger, truck, and bus tires based upon above assumptions.

Sources:

(a) "Industry Statistics," 1967 Census of Manufacturers, U.S. Department of Commerce, Vol. II, Part 2 Major Groups 25-33, 1971, pp. 30A1-33.

(b) "General Statistics for Industry Groups and Industries," Annual Survey of Manufactures - 1971, U.S. Department of Commerce, Publication M71 (AS)-1, April 1973.

(c) "General Statistics for Industry Goups and Industries," 1972 Census of Manufactures (Advance Report), U.S. Department of Commerce, Publication MC72 (A)-1.

(d) "Tires and Inner Tubes: Trends and Projections 1967-1974," U.S. Industrial Outlook 1974, U.S. Department of Commerce, p. 119.

(e) Telephone interview with Mr. David Blank of the Chemical Section of the U.S. Department of Commerce, Washington, March 14, 1974.

(f) "Uniroyal's Vila Says Dollar Sales Should Rise 4%," Rubber & Plastics News, December 31, 1973, p. 5.

(g) "Rubber Fabricating," Discard Basic Analysis (Section 2), December 31, 1973, p R 192.

EXHIBIT VIII-5
FEO: USDC
SIC 3011 - PRODUCTION VOLUME - 1967, 1971 - 1974
(Tires in Millions)

LINE	ITEM	1967	1971	1972	1973	1974 [7] Low	1974 [7] High
1.	Total production of SIC 3011 industry [1]	315.8	362.6	364.2	364.0	383	412
2.	Production of SIC 3011 products by SIC 3011 industry [2]	262.5	307.7	311.2	311.7	328	353
3.	Production of SIC 3011 products by all industries [3]	265.0	309.0	313.2	313.6	330	355
4.	Ratio of production of SIC 3011 products by SIC 3011 industry to production of SIC 3011 products by all industries [4]	0.99	0.99	0.99	0.99	0.99	0.99
5.	Production of major SIC 3011 products by SIC 3011 industry [5]						
	Passenger car tires	143.6	187.6	195.2	188.6	196	209
	Truck and bus tires	20.1	28.4	30.1	34.2	37	41
	Other tires, tubes, tread rubber, etc.	(X)	(X)	(X)	(X)	(X)	(X)
6.	Production of major SIC 3011 products by SIC 3011 industry expressed in "equivalent passenger tires:" [6]						
	Passenger car tires	143.6	187.6	195.2	188.6	196	209
	Truck and bus tires	71.4	79.3	80.2	86.8	94	103
	Other tires, tubes, tread rubber, etc.	47.5	40.8	35.8	36.3	38	41

Footnotes:

(1) Figures obtained from quantities in line 2 using ratio of total value of products and services sold by SIC 3011 industry to value of SIC 3011 products shipped by the industry (see Exhibit VIII-3).

(2) Figures expressed in "equivalent passenger tires" and are equal to sums of quantities in line 6.

(3) Figures obtained from quantities in line 2 using ratios given in line 4.

(4) Ratios are those which were established for the values of shipments for this industry (see Exhibit VIII-3).

(5) Figures for 1967 obtained from Source (a). Figures for 1971 and 1972 obtained from Source (b). Figures for 1973 obtained from Source (c).

(6) Figures for truck and bus tires and "other" category expressed in "equivalent passenger car tires" produced, obtained from data in Exhibit VIII-5 using, respectively, the ratio of truck and bus tires produced to truck and bus tires shipped and a weighted average of passenger car, truck, and bus tires produced to passenger car, truck, and bus tires shipped.

(7) Figures for 1974 built up from quantities estimated for individual product categories. Figures in line 5 obtained using following assumptions (see also Sources (d) and (e)).

	Low	High
Passenger tires (original equipment)	down 10% from '73	same as in '73
Passenger tires (replacement)	same as in '73	up 5% from '73
Truck and bus tires	same as in '73	up 10% from '73

The figures in line 6 are those presented in Exhibit VIII-6, i.e., production volume is assumed to equal quantity shipped.

Sources:

(a) "Industry Statistics," 1967 Census of Manufactures, U.S. Department of Commerce, Vol. II, Part 2 Major Groups 25-33, 1971, pp. 30A1-33.
(b) "Rubber Industry Facts," Rubber Manufacturers Association, Inc., New York, N.Y., February 6, 1974.
(c) Preliminary statistics from Rubber Manufacturers Association, Statistical Department, New York, N.Y.
(d) "Uniroyal's Vila Says Dollar Sales Should Rise 4%," Rubber & Plastics News, December 31, 1973, p. 5.
(e) "Rubber Fabricating," Discard Basic Analysis (Section 2), December 31, 1973, p. R192.

EXHIBIT VIII-6
FEO: USDC
SIC 3011 - SHIPMENTS IN EQUIVALENT PASSENGER TIRES(1)
1967, 1971-1974
(Dollars and Tires in Millions)

LINE	ITEM	1967	1971	1972	1973	1974(4) Low	1974(4) High
1.	Average value per passenger car tire (2)	$ 11.72	$14.48	$ 15.60	$16.68	$ 19.18	$ 19.18
2.	Passenger car tires:						
3.	Total value of passenger car tire shipments by SIC 3011 industry (3)	$1,713.0	$ 2,680.7	$3,033	$ 3,359	$ 3,760	$ 4,003
4.	No. of passenger car tires shipped by SIC 3011 industry (2)	146.1	185.1	194.4	201.3	196	209
5.	Truck and bus tires:						
6.	Total value of truck and bus tire shipments by SIC 3011 industry (3)	$ 828.8	$ 1,169.1	$ 1,371	$ 1,558	$ 1,792	$ 1,972
7.	No. of equivalent passenger car tires shipped by SIC 3011 industry (1)	70.7	80.7	87.9	93.4	94	103
8.	Other tires, tubes, tread rubber, etc.						
9.	Total value of "other" category shipments by SIC 3011 industry (3)	$ 561.6	$ 589.4	$ 572	$ 649	$ 733	$ 789
10.	No. of equivalent passenger car tires shipped by SIC 3011 industry (1)	47.9	40.7	36.7	38.9	38	41
11.	Total no. of equivalent passenger car tires shipped by SIC 3011 industry (sum of lines 4, 7, and 10) (1)	264.7	306.5	319.0	333.6	328	353

Footnotes:

(1) "Equivalent passenger car tires" obtained by dividing the total value of shipments of each product category by the average value per passenger car tire.

(2) Figures obtained from data presented in Source (a) and information from Source (b).

(3) Figures obtained from Exhibit VIII-3.

(4) Ranges are those established in Exhibit VIII-4.

Sources:

(a) "Tires and Inner Tubes: Trends and Projections 1967-1974," U.S. Industrial Outlook 1974, U.S. Department of Commerce, p. 119.

(b) Telephone interview with Mr. David Blank of the Chemical Section of the U.S. Department of Commerce, Washington, March 14, 1974.

EXHIBIT VIII-7
FEO: USDC
SIC 3011 - ENERGY FACTORS - 1967, 1971, 1973
(Per Million Equivalent Passenger Car Tires Produced)

Item	Units	Year 1967 (2)	1971 (3)	1973 (4)
Total equivalent production (1)	Millions of equivalent passenger car tires	316	363	364
BTU equivalency of fuels and purchased electricity		262.6	290.8	290.8
Coal	Thousand short tons	4.00	2.27	1.5
Fuel Oil				
Distillates	1,000 barrels	0.69	3.36	4.5
Residuals	1,000 barrels	1.15	1.51	1.7
Gas	Billion cubic feet	0.055	0.080	0.092
Purchased Electricity	Million KWH	8.47	11.29	11.29

(1) From Line 1, Exhibit VIII-5.
(2) The total amounts for each item in census "Fuels and Electric Energy Consumed," MC 67(S)-4 divided by total equivalent production.
(3) The total amounts for each item in census "Fuels and Electric Energy Consumed," MD 72 (SR)-6 divided by equivalent production.
(4) Snell estimates of energy items based on extrapolation of 1967 to 1971 trends for fuel items and assuming the change in purchased electricity use is proportional to the overall change in fuel BTUs.

SECTION IX

SIC 3021 RUBBER FOOTWEAR

Exhibit IX-1 at the end of this section, presents a detailed industry definition. In 1971, value added by manufacture was $297 million according to the Annual Survey of Manufactures, while value of shipments was $512 million and total gross book value of depreciable assets was $150 million. The same source reports energy consumption of 0.8 billion KWH equivalents. County Business Patterns, 1972, reports that about 80 establishments were classified in SIC 3021.

The most important findings follow regarding the economic impact of the petroleum based materials shortages during 1973 and the first quarter of 1974:

- Fuel shortages were of concern but did not cause serious disruptions
- Raw material shortages were claimed particularly for synthetic rubber and compounds for injection molded canvas footwear
- Employment was not significantly affected, although no appreciable gains for 1974 were projected
- No near-term opportunities for substitution or conservation of fuels were identified
- Injection molded footwear is significantly less energy intensive than hand-built footwear

Exhibit IX-2, following Exhibit IX-1, features the Required Tables. These tables and supporting exhibits further define the industry's structure both in economic and energy terms.

All exhibits appear sequentially at the end of this section. Whenever electricity KWHs are expressed as BTUs, conversion is based on the nominal fuel requirements to generate the electricity.

1. MAJOR USES OF FUELS, ENERGY AND PETROLEUM PRODUCTS

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

1.1 Task I, Major Processes

There are two characteristic products in this sector:

- SIC 302101 Rubber & Canvas Footwear
- SIC 302102 Protective Rubber Footwear

It is seen from Exhibit IX-3 that canvas footwear is the principal product of the industry accounting for 64% of the value of all products and services sold by SIC 3021 industry. Canvas rubber footwear is currently made by two processes: the conventional or autoclave process (also referred to as hand-built); and injection molding (also referred to as machine-made).

The traditional method of making canvas footwear is actually constructing the shoes by hand; piece by piece, and then putting the shoes in a large vulcanizing oven as a final production step.

The injection mold, or machine-made, process was a significant technological break-through. This process began in the late 1950s and revolutionized canvas footwear production. Shipments of machine made shoes have grown steadily and by 1972 accounted for about two thirds of all such shipments.

The process is automatic and involves injecting either PVC or a thermoplastic rubber compound from an extruder into a mold which contains a string lasted upper. No vulcanization is required. The injection machine may have as many as sixteen stations and finished shoes are produced in a matter of a few seconds. In the modern plants, the compounds are mixed and color blended by computer. Very little labor is involved except stitching the uppers.

Footwear made by injection molding is low-cost and highly competitive, generally priced lower than imports. Most of this footwear retails for less than $3 per pair. Footwear made by the conventional, autoclave method retails for $4 to $9 per pair and is considered better quality than the injection molded product.

The industry is a significant user of synthetic rubber and petrochemically-based textiles. It uses electricity for such mechanical functions as mixing and forming. Oil and gas are used as sources of heat for vulcanization and curing.

1.2 Task II, Industry Output

Exhibit IX-3 summarizes value of shipments for 1967, and 1971 to 1974. In 1973 this was $535 million for all products and services sold by SIC 3021 industry. Exhibit IX-4 presents production volume for the same periods, and in 1973 this totaled 216 million pairs. Exhibit IX-2-5, Required Table 5, shows the 1973 output data.

1.3 Task III, Energy Related Profile of Major Processes

No specific energy factors were developed for injection molding, hand building of canvas shoes or other production activities of this industry. Hand building is several times more energy intensive per pair of shoes than injection molding. The industry average is about 19,000 BTUs per equivalent pair of product, based on estimates from census data in Exhibit IX-5.

According to Commerce Department sources, at the beginning of 1973 the industry consisted of 31 firms operating 55 plants. Seven of these firms - operating 25 plants - account for all of the U.S. production of hand-built footwear as well as substantial quantities of machine-made footwear. Thus, 24 firms operating 30 plants account for all the machine-made footwear not accounted for by the seven firms.

1.4 Task IV, Shifts In The Energy Related Profile Of The Industry - 1971 to 1973

Exhibit IX-2-5 presents Required Table 5. In 1971 the rubber footwear industry required approximately 4,040 billion BTUs of fuel and energy. In 1973 this was 4,020 billion BTUs, accounting for about a 0.4% decrease.

1.5 Task V, Projected 1974 Energy Related Profile Of The Industry

A 1.9% increase is projected for 1974 due to possible production of a greater number of equivalent pairs of rubber shoes, as shown in Exhibit IX-4.

2. GEOGRAPHIC PATTERN OF USE

The principal outputs from the tasks of this subsection are analysis of findings.

2.1 Task I, Geographic Pattern of the Industry's Energy Related Profile - 1971 to 1973

The secondary sources do not provide the information necessary to regionally disaggregate industry level energy profiles with quantitative significance. See 2.2, below, for further discussion. Required Tables 6 and 7 are, therefore, not presented.

2.2 Task II, Geographic Pattern of Employment and Shipments

Sufficient data is not available in the secondary sources examined to serve as basis for geographically distributing the consumption of energy, employment and value of shipments. The table below summarizes available data on employment patterns with an estimate of change from 1971 to 1973.

State or Region	Employment 1971	1972	1973	1971 to 1973 % Change
United States (1)	25,500	25,500	27,500	8
United States (2)	27,644	29,986		
Maine	1,825	1,778		
New Hampshire	(NA)	2,007		
Massachusetts	(NA)	3,113		
New York	1,264	1,193		
Pennsylvania	2,384	2,564		
North Carolina	2,639	2,437		
Florida	(NA)	2,378		

Sources

(1) Bureau of Labor Statistics

(2) County Business Patterns 1971 and 1972, including all states

No attempt was made to use these limited data to distribute value of shipment or energy BTUs geographically. Employment is a poor index of shipments or energy use because hand-built operations, for example, are significantly more labor and energy intensive than the injection molding process. Therefore, Required Table 8 is not available.

3. FUEL AND ENERGY SITUATION

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

3.1 Task I, "Normal" Stocks of Materials

To minimize working capital, rubber reclaimers do not typically stockpile materials in addition to reasonable inventory management needs.

A one month material supply, including order and shipping time, appear to be normal for synthetic rubber and textile materials. Gas and electricity are furnished by utilities. Oil, when used, is stocked at a maximum one month tankage capability.

3.2 Task II, Shifts in Stocks

Shifting of oil stocks represents a seasonal pattern, with significant drawdown as spring approaches. This pattern apparently has carried into 1974, consistent with prior year practice, as shown in Exhibit IX-2-9, Required Table 9.

3.3 Task III, Captive Use

There is no significant captive energy or materials production in this sector. Therefore, Required Table 10 is not applicable.

3.4 Task IV, Sources of Supply

Distillates and residual fuel oil are obtained principally from wholesalers. Natural gas and electricity are procured from utilities. Required Table 11 is not shown.

3.5 Task V, Proportion By Type of Supplier

See discussion above.

3.6 Task VI, Seasonality of Use

This is presented in Exhibit IX-2-12, Required Table 12, showing a summer low for distillates usage and a winter low for natural gas.

4. SUBSTITUTABILITY AND CONSERVATION OF MAJOR FUELS AND PETROLEUM PRODUCTS

The findings under this section were developed through industry interviews, review of secondary sources and review of in-house information.

4.1 Task I, Major Processes

Substitutability of materials is feasible within limits posed by market acceptance of product, including codes and specifications in some SIC 302102 lines. However, the risks and cost involved do not generally appear warranted, since overall petroleum based savings do not occur.

Energy source substitution does not appear practical in most cases, at least in the near term.

Efforts have been made to decrease energy wastage, including reducing of thermostat settings in work areas, repair of steam valves and insulation, and reduction of lighting levels.

4.2 Task II, Quantification of the Major Substitutability and Conservation Opportunities

Conservation measures have probably achieved energy savings of the order of 5%.

4.3 Task III, Principal Constraints

If conservation and substitution raise costs appreciably, the industry is exposed to stronger challenge from imports.

4.4 Task IV, Plant Level Operating Characteristics

See discussion under subsection 1, Tasks I and III.

4.5 Task V, Capital Stock (1973)

The 1973 gross book value of fixed assets was about $150 million. This estimate is based on the following:

- The 1971 Annual Survey of Manufactures indicates that the gross book value of fixed assets was $150 million in 1971.
- One of the largest manufacturers of rubber footwear discontinued operations in 1972.
- Output of canvas footwear is showing a slight upward trend.
- The slight upward trend in the industry is the result of increases in the manufacture of machine-made canvas footwear requiring outlays for capital equipment.

Capital expenditures in the industry in 1972 are estimated at about $14 million, most of which is assumed to have gone for the equipment to produce an additional 11-12 million pairs of canvas footwear. At an average capital investment of about $1 per pair of footwear for an industry producing about 220 million pairs of footwear at about 85% of capacity, the replacement value of present production capacity is about $250 million.

4.6 Task VI, Planned Capital Investment (1974)

Estimates for increased U.S. production in this industry indicate a growth in the production of machine-made canvas footwear of about 5 million pairs per year over the next couple of years. Capital investment in 1974 of around $6-8 million can therefore be expected.

4.7 Task VII, Changes to Investment Plans

The serious economic crunch brought on by rapidly-increasing materials costs and inability to pass these increases on to the consumer has caused cash flow problems that preclude additional investments in this sector at this time. Smaller firms may be experiencing liquidity problems.

5. INTRA-INDUSTRY EFFICIENCY

The findings in this section have been developed through an analysis of industry and in-house data and industry interviews.

5.1 Task I, Energy Efficiency

Energy efficiency in BTU per pounds or pairs of product varies considerably with product mix, as discussed under subsection 1. Old, autoclave process plants probably consume several times more energy than injection molding plants. The autoclave process provides a higher quality product.

5.2 Task II, Major Factors Affecting Efficiency

Routine plant maintenance and energy discipline are the major significant factors in energy efficiency. Personnel and machinery schedule changes have been tried, with possible modest success.

6. PRINCIPAL CONSTRAINTS ON CURRENT INDUSTRY OPERATIONS

The findings presented in this section have been obtained through industry interviews and through the analysis of secondary sources and in-house information.

6.1 Task I, Important Constraints

Availability of synthetic rubber, textiles, pigments, curing agents, and other process chemicals are generally constraints on the rubber footwear industry. There can be a considerable impact on the production of injection molded footwear. The principal materials used by this process are polyvinyl chloride (PVC) and a thermoplastic compound usually sold under brand names, ("Kraton", etc.).

The industry may also be adversely affected if Kraton, which is a substitute for leather shoe soles, is bid away from the canvas footwear producers by manufacturers of higher priced men's and women's nonrubber footwear. If this situation were to occur, the industry could not switch to PVC to keep output from declining. PVC is not a substitute for Kraton because footwear made from PVC is not suitable in wet areas.

Imports are reported as a serious competitive constraint. According to Commerce Department sources, imports during 1968-1972 accounted for about 22 to 27 percent of apparent domestic consumption. In 1972 the penetration ratio was about 25 percent.

6.2 Task II, Most Serious Constraint

Injection molded products are reported most competitive with imports. If raw materials in this process experience significant shortages or major price increases, the vulnerability of the industry would be greatly increased, provided these phenomena did not occur overseas.

6.3 Task III, Shortfall in Supply and Price Increases

Synthetic rubber is at approximately 80% allocation level (first quarter of 1974). Price increases of approximately 50% on materials have been reported from early 1973 through the first quarter of 1974.

6.4 Task IV, Outputs Critical to Subsequent Production

The output of this sector is important to consumer activities, and protective rubber footwear is vital in a broad range of industrial activities.

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EXHIBIT IX-1
FEO: USDC
DEFINITION OF SIC 3021 (1)

SIC 3021 RUBBER AND PLASTICS FOOTWEAR

Establishments primarily engaged in manufacturing all rubber and plastics footwear, waterproof fabric upper footwear, and other fabric upper footwear having rubber or plastic soles vulcanized to the uppers. Establishments primarily engaged in manufacturing rubber, composition, and fiber heels, soles, soling strips, and related shoe making and repairing materials are classified in Industry 3069; plastic soles and soling strips in Industry 3079.

Arctics, rubber or rubber soled fabric
Boots, plastics
Boots, rubber or rubber soled fabric
Canvas shoes, rubber soled
Footholds, rubber
Footwear, rubber or rubber soled fabric
Gaiters, rubber or rubber soled fabric
Galoshes, plastics
Galoshes, rubber or rubber soled fabric
Overshoes, plastics
Overshoes, rubber or rubber soled fabric
Pacs: rubber or rubber soled fabric
Sandals, rubber
Shoes, plastics soles molded to fabric uppers
Shoes, rubber or rubber soled fabric uppers
Shower sandals or slippers, rubber

Source: 1972 Standard Industrial Classification Manual

(1) The 1972 SIC definition is the same as that used in the 1967 census.

EXHIBIT IX-2-1
FEO:USDC
REQUIRED TABLE 1

Proportion of Industry Output Accounted for by Each Major Process, 1973

SIC 3021 Industry Rubber Footwear

Process and Major Products	Percent of 1973 Shipments Value	Percent of 1973 Production Volume 1/
Canvas footwear	64.7%	69.1%
Waterproof footwear	13.8	8.1
Other	5.4	5.1
Secondary products and miscellaneous receipts	16.1	17.7
Total Industry (Percent)	100.0	100.0
(Actual)	$535,000,000	216,300,000

1/ Production volume expressed in pairs.

Source: Exhibits IX-3 and IX-4.

EXHIBIT IX-2-5
FEO: USDC
REQUIRED TABLE 5

Industry Consumption of Fuels, Petroleum Products, and Energy by Type - 1971, 1973, and 1974

SIC 3021 Industry Rubber Footwear

Line No.	Type of Energy or Material	Unit of Measure	Volume (1)			Bil. BTU s (2)			% Change		% of Total BTU s	
			1971	1973	1974	1971	1973	1974	1971-73	1973-74	1971	1974
1	Propane, butane, and mixtures											
2	Middle distillates	1,000 barrels	119.4	119.0	121	695	693	706	(0.3)	1.9	17.2	17.2
3	Residual fuel oil	1,000 barrels	75.7	75.7	77.2	476	476	485	(Z)	1.9	11.8	11.8
4	Chemical feedstocks											
5	Other petroleum, products, total											
6	Petroleum products, total											
7	Coal	1,000 short tons	1.00	1.08	1.10	26.2	28.3	28.9	8.0	2.1	0.6	0.7
8	Natural gas	billion cu. ft.	0.70	0.69	0.71	722	714	728	(1.1)	2.0	17.9	17.8
9	Fuels, n.e.c. total											
10	Other fuels, total											
11	Electrical energy (purchased only)	million KWH	200	199	203	2,120	2,110	2,150	(0.5)	1.9	52.5	52.5
12	GRAND TOTAL		(X)	(X)	(X)	4,039	4,021	4,098	(0.4)	1.9	100%	100%

(1) The energy factors of Exhibit IX-5 multiplied by production figures from Line 1 of Exhibit IX-4, using the "High" and "Low" average production as well as the 1973 energy factors for 1974 projections.

(2) BTU s and cu. ft. of Natural Gas have been changed to billions from millions.

EXHIBIT IX-2-9
FEO: USDC
REQUIRED TABLE 9

Stocks of Fuels and Petroleum Products by Type, 12/31/73 and 3/31/74

SIC 3021 Industry Rubber Footwear

Line Number	Type of Energy or Material	Stocks (# of days supply related to average daily requirements in next quarter)					
		As of December 31			As of March 31		
		1971	1972	1973	1972	1973	1974
1	Propane						
2	Butane						
3	Propane Butane Mixture						
4	Middle Distillates	30	30	30	15	15	15
5	Residual Fuel Oil						
6	Chemical Feedstocks						
7	Other Petroleum Products, total						
8	Coal						
9	Natural Gas (Pipeline)						
10	Fuels, n.e.c., total						

Source: Illustrative but statistically not validated data based on industry interviews.

EXHIBIT IX - 2-12
FEO: USDC
REQUIRED TABLE 12

Seasonal Use of Fuels, Petroleum Products and Energy by Type, 1973

SIC 3021 Industry Rubber Footwear

Line Number	Type of Material or Energy	Percent of Annual Use in 1973 in Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.
1	Propane, butanes and mixtures				
2	Distillates	35	25	15	25
3	Residual	35	25	15	25
4	Feedstocks				
5	Other petroleum products				
6	Coal				
7	Natural gas	20	25	30	25
8	Other fuels				
9	Electrical Energy (purchased)	25	25	25	25

Source: Illustrative, but statistically not valided data based on industry interviews.

EXHIBIT IX-3
FEO: USDC
SIC 3021[1] - VALUE OF SHIPMENTS - 1967, 1971-1974
(Dollars in Millions)

LINE	ITEM	1967	1971	1972	1973	1974[7] Low	1974[7] High
1.	Value of products and services sold by SIC 3021 industry[2]	$427.0	$519.8	$524.5	$535.0	$612	$620
2.	Value of SIC 3021 products shipped by SIC 3021 industry[3]	351.5	437.1	440.5	449.5	514	521
3.	Value of SIC 3021 products shipped by all industries[4]	374.6	465.3	469.5	478.9	548	555
4.	Ratio of value of SIC 3021 products shipped by SIC 3021 industry to value of SIC 3021 products shipped by all industries (coverage ratio)[5]	0.94	0.94	0.94	0.94	0.94	0.94
5.	Value of major SIC 3021 product groups shipped by SIC 3021 industry[6]						
	Canvas footwear	$259.0	$334.7	$350.1	$346.4	$403	$407
	Waterproof footwear	70.6	74.8	71.3	74.0	79	82
	Other	21.9	27.7	28.0	29.1	32	32

Footnotes:

(1) Industry defined as per the 1967 classification of rubber footwear.

(2) Figures for 1967 and 1971 obtained from Sources (a) and (b). Figures for 1972 and 1973 determined from data given in Source (c).

(3) Figure for 1967 determined from data given in Source (a) and estimate that secondary product shipments of the SIC 3021 industry in that year were approximately $50 million, i.e. that the shipments of shoes other than rubber ($20.4 million) and fabricated rubber products, n.e.c. ($17.6 million) represented about 75% of all secondary product shipments. Figures for 1971-1973 calculated from values in line 3 using ratio given in line 4.

(4) Figures for 1967 and 1971 obtained from Sources (a) and (d). Figures for 1972 and 1973 obtained from values in line 1 using same ratio as for 1971.

(5) Ratio for 1967 calculated from values given in lines 2 and 3. Ratio for 1971-1974 assumed to be same as for 1967.

(6) Figures for 1967 calculated from data in Source (a) using ratio given in line 4. Figures for 1971-1974 calculated from shipment volume data obtained through Source (e) (modified for canvas footwear using data from Source (f)) using the ratio given in line and the following price index: 1967-1.00, 1971-1.265, 1972-1.267, 1973-1.280.

(7) Figures for 1974 built up from values for individual product categories in line 5 which is estimated to range as follows:

Category	"Low" Figure	"High" Figure
Canvas footwear	Zero growth	Quantity shipped grows at historical rate (1967-1973)
Waterproof footwear	Quantity shipped grows (negatively) at historical rate (1967-1973)	Zero growth
Other	Zero growth	Zero growth

In all cases, it is assumed that prices are 15% higher than in 1973.

Sources:

(a) "Industry Statistics," 1967 Census of Manufactures, U.S. Department of Commerce, Vol. II, Part 2 Major Groups 25-33, 1971, pp 30A1-33.

(b) General Statistics for Industry Groups and Industries," Annual Survey of Manufactures - 1971, U.S. Department of Commerce, Publication M71 (AS)-1, April 1973.

(c) "Rubber and Miscellaneous Plastics Products," U.S. Industrial Outlook 1974, U.S. Department of Commerce, Domestic and International Business Administration, pp. 114-5.

(d) "Value of Product Shipments," Annual Survey of Manufactures-1971, U.S. Department of Commerce, Publication M71 (AS)-2, October 1973.

(e) Telephone interview with Mr. Melville Gumbs, Rubber Manufacturers Association, Inc., New York, N.Y., March 18, 1974.

(f) Telephone interview with Mr. Clinton Shaw, U.S. Department of Commerce, Bureau of Resources and Trade Assistance, March 15, 1974.

EXHIBIT IX-4
FEO: USDC
SIC 3021[1] - PRODUCTION VOLUME - 1967; 1971-1974
(Pairs in Millions)

Line	Item	1967	1971	1972	1973	1974[7] Low	1974[7] High
1.	Total production by SIC 3021 industry[2]	208.4	217.4	209.4	216.3	219	222
2.	Total production of SIC 3021 products by SIC 3021 industry[3]	171.5	178.9	172.3	178.0	180	183
3.	Total production of SIC 3021 products by all industries[4]	182.7	190.6	183.6	189.7	192	195
4.	Ratio of production of SIC 3021 products by SIC 3021 industry to production of SIC 3021 products by all industries[5]	0.94	0.94	0.94	0.94	0.94	0.94
5.	Production of major SIC 3021 products by SIC 3021 industry[6]						
	Canvas footwear	138.5	147.8	144.0	149.4	152	154
	Waterproof footwear	21.9	20.0	17.2	17.5	17	18
	Other	11.1	11.1	11.1	11.1	11	11

Footnotes:

(1) Industry defined as per the 1967 classification of rubber footwear.

(2) Figures in "equivalent" production of SIC 3021 products calculated from figures in line 2 by applying ratio of the total value of SIC 3021 products and services sold by SIC 3021 industry to the value of SIC 3021 products shipped by the industry (see Exhibit IX-3).

(3) Figures are sums of the production volumes for the major product categories in line 5.

(4) Figures for 1967 obtained from data in Source (a). Figures for 1971-1973 obtained from values in line 2 using ratios in line 4.

(5) Ratio is that which was established for the value of shipments for this industry (see Exhibit IX-3).

(6) Figures for 1967 obtained from data in Source (a) modified by ratio given in line 4. Figures for 1971-1973 obtained from data from Sources (b), (c), and (d) modified by ratio given in line 4.

(7) Figures for 1974 built up from quantities estimated for individual product categories which are estimated to range from the "low" to "high" figures for quantity shipped (see Exhibit IX-3).

Sources:

(a) "Industry Statistics", 1967 Census of Manufactures, U.S. Department of Commerce, Vol. II, Part 2 Major Groups 25-33, 1971 pp. 30A1-33.

(b) Telephone interview with Mr. Melville Gumbs, Rubber Manufacturers Association, Inc., New York, New York, March 18, 1974.

(c) "Rubber and Miscellaneous Plastics Products", U.S. Industrial Outlook 1974, U.S. Department of Commerce, Domestic and International Business Administration, pp. 114-5.

(d) Telephone interview with Mr. Clinton Shaw, U.S. Department of Commerce, Bureau of Resources and Trade Assistance, March 15, 1974.

EXHIBIT IX-5
FEO: USDC
SIC 3021 - ENERGY FACTORS - 1971
(Per Million Pairs Produced)

Line	Item	Units	Year 1971 (1)
1	Production (1)	Million pairs	217.4
2	BTUs equivalent of fuels	Billion BTUs	8.82
3	Coal	1,000 short tons	0.0046
4	Distillates	1,000 barrels	0.549
5	Residual	1,000 barrels	0.348
6	Natural gas	Billion cu. ft.	0.00322
7	Other fuels	Million dollars	(Z)
8	Fuels nsk.	Million dollars	(Z)
9	Electricity purchased	Million KWH	0.92
10	BTUs equivalent of purchased electricity	Billion BTUs	9.75
11	Electricity generated	Million KWH	(Z)
12	BTUs equivalent of fuels and purchased electricity	Billion BTUs	18.57

(1) Census data from "Fuels and Electric Energy Consumed," MC72(SR)-6, divided by total production figures from Line1, Exhibit IX-4.

SECTION X

SIC 3031, RECLAIMED RUBBER

Exhibit X-1 at the end of this section, presents a detailed industry definition. In 1971 value added by manufacture was $18 million according to the Annual Survey of Manufactures, while value of shipments was $32 million and total gross book value of depreciable assets was $26 million. The same source reports energy consumption of 0.3 billion KWH equivalents. County Business Patterns, 1972, reports that about 30 establishments were classified in SIC 3031. The 1972 Census of Manufactures reports this to be 21.

The most important findings follow regarding the economic impact of the petroleum based materials shortages during 1973 and the first quarter of 1974:

- Fuel shortages were of concern but did not cause serious disruptions
- Concern with availability of supplies, but no major raw material shortages were indicated
- No major near-term opportunities for substitution or conservation of fuels were identified
- There are appreciable differences in the energy efficiency of major processes.

Exhibit X-2, following Exhibit X-1, features Required Tables. These tables and supporting exhibits further define the industry's structure both in economic and energy terms.

All exhibits appear sequentially at the end of this section. Whenever electricity KWHs are expressed as BTUs, conversion is based on the nominal fuel requirements to generate the electricity.

1. MAJOR USES OF FUELS, ENERGY AND PETROLEUM PRODUCTS

The principal outputs from the tasks of this subsection are Required Tables and analyses of findings.

1.1 Task I, Major Processes

The reclaimed rubber industry converts rejected products into reuseable materials. Scrap tires are reclaimed and converted to a soft workable state wherein they are capable of being blended into tire compounds for new tire manufacture. Some materials are produced which are not reused in the rubber industry but in other industries. Some examples are adhesives, wire covering, pipe covering, brake linings, rubberized asphalts and tars. However, this is a small portion of a "Reclaimer's" operations.

Rubber reclaiming includes three major steps:

- Grinding to scrap rubber to aid in separating fibers and to permit subsequent blending with reclaiming oil.

- Depolymerization or "devulcanization" in which the rubber is partly broken down and is further softened by absorbent or (usually high aromatic) "reclaiming oil."

- Compounding and milling to cement the cleaned and softened rubber to a form suitable for blending with new rubber in tire working or for the molding or extrusion of reclaimed rubber articles, etc.

Devulcanization is the most important step and can be performed in each of three ways:

- wet process digesting, including the high pressure "dynamic digesting" (Digester)
- mechanical reclaiming process (Reclamator)
- dry devulcanizing process (Pan)

Exhibit X-3 presents a schematic representation of the rubber reclaiming process.

1.2 Task II, Industry Output

Since 1967 the industry has been operating at between 65% and 70% of production capacity. Recently this percentage has increased due to the closing of some reclaiming operations and the continued or even increased demand for reclaimed rubber.

Exhibit X-4 summarizes value of shipments for 1967 and 1971 to 1974. For 1973 the value of products and services sold by SIC 3031 industry was approximately $31.3 million, down from $32.1 million in 1971.

Exhibit X-5 summarizes production volume in similar terms. Total production by SIC 3031 industry was approximately 294 million lbs in 1973, down from 305 million lbs in 1971.

Exhibit X-2-1 presents Required Table 1, dealing with 1973 industry output.

1.3 Task III, Energy Related Profile of Major Processes

Energy factors for the major processes appear in Exhibit X-6.

In the Digester process, energy requirements are 0.35 KWH electrical and 1560 BTU steam per lb of reclaim.

In the devulcanizer (Pan) process electrical needs are 0.33 KWH per lb, while steam input of 545 BTU steam per lb is needed. "Dynamic" devulcanization includes agitation in the process, adding about 10% to the overall KWH equivalents per lb of reclaim.

Requirements in the Reclamator process are all electrical, 0.61 KWH per lb reclaim.

Exhibits X-2-2,3 and 4, "a" through "c", present the energy profiles of the three major processes. These accounted for 1500 billion BTUs in 1971. According to census data as shown in Exhibit X-2-5, the industry consumed 2300 billion BTUs in 1971. The discrepancy may be due to the energy factors in Exhibit X-6 representing better than industry average performance, minor uncertainties in the proportion of product accounted for by each major process, or overstatement of energy use by the industry by census.

1.4 Task IV, Shifts In The Energy Related Profile Of The Industry - 1971 to 1973

Exhibit X-2-5 presents Required Table 5, the energy profile of SIC 3031 industry. From 1971 to 1973 there was essentially no change in the fuel and energy requirements of rubber reclaiming. Annual overall energy requirements were approximately 2,300 billion BTUs. Electrical energy accounted for about 46% of BTUs, natural gas for 31%, coal 20% and fuel oils 3%. The industry depends directly on petroleum based fuels only for a small fraction of its heat and power needs.

1.5 Task V, Projected 1974 Energy Related Profile of The Industry

The projected 1974 requirements are essentially the same as those for 1973, seen in Exhibit X-2-5.

2. GEOGRAPHIC PATTERN OF USE

The principal output from the tasks of this subsection are analysis of findings.

2.1 Task I, Geographic Pattern of the Industry's Energy Related Profile - 1971 to 1973

The industry is principally located in Ohio and the northeastern seaboard. The members of the Rubber Reclaimers Association, Inc. are located in Ohio (2), Illinois, New Jersey, Connecticut, Pennsylvania, and Missouri.

The secondary sources reviewed do not define plant capacities, employment, value of shipments or energy use regionally. About one-half of industry operations are classified in the North Central Census Region. Required Tables 6 and 7 are not shown in this section.

2.2 Task II, Geographic Pattern of Employment and Shipments

For the reasons stated above, employment and shipments distribution, Required Table 8, is not available in this section.

Nationally, from Exhibit X-3, the value of products and services sold by SIC 3031 industry was $31.2 million in 1971 and $31.3 million in 1973. The "County Business Patterns," 1971 and 1972 reports industry employment of 1513 and 1643, respectively.

2.3 Task III, Shifts in the Patterns

There was no significant change in the value of shipments of the SIC 3031 industry from 1971 to 1973.

The change in employment levels from 1971 to 1972 was approximately an 8.6% increase. Industry interviews indicate that there was no appreciable further increase from 1972 to 1973. Total employment in 1974 is not expected to change appreciably from 1973.

3. FUEL AND ENERGY SUPPLY SITUATION

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings, based on industry interviews.

3.1 Task I, "Normal" Stocks of Materials

One major respondent uses coal as principal fuel and has experienced no changes in the stocks of coal. Another major reclaimer uses natural gas, has a three day standby supply of fuel oil and maintains a one month inventory of reclaiming oils, carbon blacks, etc. A third producer also uses principally coal and stocks one week's supply, while raw materials are maintained at a one month inventory.

3.2 Task II, Shifts in Stocks

Exhibit X-2-9 presents Required Table 9, showing changes in the stocks of one major reclaimer. This respondent expects a higher inventory of fuels and petroleum based materials as of March 31, 1974, than during the previous reporting periods.

3.3 Task III, Captive Use

There is captive generation of electricity. Some petroleum-based raw materials are also captively obtained. Required Table 10 is not shown in Exhibit X-2, since information is only of a qualitative nature.

3.4 Task IV, Sources of Supply

Coal is obtained from local mining companies, fuel oil from wholesalers or refineries and natural gas and electric power from utilities.

3.5 Task V, Proportion by Type of Supplier

Required Table 11 is not shown in Exhibit X-2 since this information is only of a qualitative nature.

3.6 Task VI, Seasonality of Use

There are essentially no seasonal variations in the reclaiming industry in terms of output. Exhibit X-2-12 shows the seasonal pattern of use of the various fuels by a major reclaimer. This respondent reports a lower output during the summer months.

4. SUBSTITUTABILITY AND CONSERVATION OF MAJOR FUELS AND PETROLEUM PRODUCTS

The findings under this subsection were developed through the assistance of interview respondents in the reclaiming industry.

4.1 Task 1, Major Processes

One respondent has already replaced wet process digestion with high pressure "dynamic" digestion and a second is now doing so. This has, or will save digestion steam, post-digestion drying steam, and a significant percentage of the high aromatic reclaiming oils formerly needed. A third reclaimer has switched from wet digesting to the dry process which has also reduced usage of reclaiming oils.

One reclaimer with specialty markets has been able to replace 90% of carbon black usage with mineral pigments.

4.2 Task 2, Quantification of the Major Substitutability and Conservation Opportunities

The industry derives approximately 30% of its BTU needs from natural gas. An appreciable shift to coal is possible if environmental regulations permit this. However, capital costs are high, up to $25 per lb steam per hour without environmental controls for a new coal fired steam generator. For each additional ton of coal consumed, 25 MCFT of gas would be conserved.

4.3 Task 3, Principal Constraints

There are no unusual constraints on making the above described process changes beyond justifying the investment.

4.4 Task 4, Plant Level Operating Characteristics

Curtailment in fuel would shut down at least one digester with associated preparatory and finishing equipment. Such fractional shutdown would, of course, have a less drastic effect on the operations of larger plants in the industry with a large number of digesters.

The economic break even point is relatively high in the rubber reclaiming industry and was variously estimated at 75% to 90% of capacity.

4.5 Task 5, Capital Stock (1973)

Capital investment in recent years has been confined mainly to capital improvements of existing facilities. Aggregate replacement value (at 1973 prices) of existing plants is estimated to be about $140 million on a "grass roots" basis. Gross book value of depreciable assets is less than $30 million.

4.6 Task 6, Planned Capital Investment

Capital expenditures planned during 1974 vary from $1 million for one respondent to almost none for others. One change-over still in construction is expected to be completed by September 1, 1974 at a cost of about $1 million. Presently planned expenditures are not expected to provide any additional production capacity.

4.7 Task 7, Change to Investment Plans

No appreciable long range capital spending plans are evident. However, one respondent is now examining the economics of a 50% expansion.

5. INTRA-INDUSTRY EFFICIENCY

The findings in this subsection have been developed through an analysis of secondary and in-house data and industry interviews.

5.1 Task 1, Energy Efficiency

There is little variation of energy consumption with size, as expansion generally involves more lines rather than larger pieces of equipment. One respondent estimated that a 50% increase in capacity would reduce the energy input per pound of product by less than 10%.

5.2 Task 2, Major Factors Affecting Efficiency

The respondents generally feel that they have already made most of the process and equipment improvements that are resonably possible, as there has been very strong economic pressure to do so. One respondent is still examining the possibility of improving output by bringing digester capacity into better balance with preparations and finishing. The potential gains would, however, be only a minor reduction in power usage.

6. PRINCIPAL CONSTRAINTS ON CURRENT INDUSTRY OPERATIONS

The findings presented in this section have been obtained through the assistance of a technical industry spokesman and through the analysis of secondary sources and in-house information.

6.1 Task 1 and 2, Important Constraints

No major constraints have developed as of March 1974 from the allocation program. One respondent using natural gas noted that gas supplies would not have been sufficient if new equipment that lowers fuel consumption had not been installed.

6.3 Task 3, Shortfall in Supply and Price Increases

Supply shortfalls that will force the industry's output below demand are not anticipated. Supplies of scrap tires for reclaiming are ample, although gathering costs are increasing rapidly, as are prices of all compounding materials, fuels and transportation. The factory cost of reclaimed rubber will continue lower than that of new rubber as inflation increases, according to one source. For the same reason a second respondent expects to be able to pass cost increases through to customers as rapidly as these occur. Another (an independent) respondent serving a variety of specialty users on contract is now experiencing a serious lag in passing on cost increases.

In estimating value of shipments for 1974 in Exhibit X-3, a 15% average price increase in 1974 was assumed.

6.4 Task 4, Outputs Critical to Subsequent Production

Reclaimed rubber cannot be readily replaced by synthetic rubber in certain adhesives and specialty molded products which require its unique properties. The largest use for reclaims is in tires where it is used to the extent of about 5-10% and where it imparts both processing and materials cost advantages. If supplies of reclaims to the tire industry were cut off, considerable development work would be needed to replace it efficiently and tire prices would probably rise somewhat in consequence, according to one respondent.

EXHIBIT X-1
FEO: USDC
DEFINITION OF SIC 3031 (1)

SIC 3031 RECLAIMED RUBBER

Establishments primarily engaged in reclaiming rubber from scrap rubber tires, tubes, and miscellaneous waste rubber articles by processes which result in devulcanized, depolymerized or regenerated replasticized products containing added ingredients. These products are sold for use as a raw material in the manufacture of rubber goods with or without admixture with crude rubber or synthetic rubber. Establishments primarily engaged in the assembly and wholesale sale of scrap rubber are classified in trade industries.

Reclaimed rubber (reworked by manufacturing processes)

Source: 1972 Standard Industrial Classification Manual

(1) The 1972 SIC definition is the same as that used in the 1967 census.

EXHIBIT X-2-1
FEO:USDC
REQUIRED TABLE 1

Proportion of Industry Output Accounted for by Each Major Process, 1973

SIC 3031 Industry Reclaimed Rubber

Process and Major Products	Percent of 1973 Shipments Value	Percent of 1973 Production Volume 1/
Digester process	46.6%	46.6%
Pan process	27.2	27.4
Reclamator process	21.7	21.7
Secondary products and miscellaneous receipts	4.5	4.3
Total Industry (Percent)	100.0	100.0
(Actual)	$31,300,000	294,300,000

1/ Production volume expressed in pounds.

Source: Exhibits X-4 and X-5.

EXHIBIT X-2-2a
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Volume (1)

SIC 3031 Industry Reclaimed Rubber

Process Digester Process

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	1,000 barrels	1.6			1.6	1.5			1.5
3	Residual fuel oil	1,000 barrels	1.7			1.7	1.6			1.6
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	1,000 short tons	4.7			4.7	4.4			4.4
8	Natural gas	billion cu. ft.	0.2			0.2	0.2			0.2
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	49.7			49.7	46.2			46.2
12	GRAND TOTAL									

Source: (1) Figures obtained by multiplying the production data of Exhibit X-5 by the energy factors of Exhibit X-6.

EXHIBIT X-2-3a
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billion BTUs

SIC 3031 Industry Reclaimed Rubber

Process Digester Process

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	billion BTUs	9.2			9.2	8.6			8.6
3	Residual fuel oil	billion BTUs	10.6			10.6	9.9			9.9
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	billion BTUs	124.1			124.1	115.4			115.4
8	Natural gas	billion BTUs	197.1			197.7	183.9			183.9
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTUs	526.8			526.8	489.9			489.9
12	GRAND TOTAL	billion BTUs				868.4				807.6

EXHIBIT X-2-4a
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Million KWH Equivalents.

SIC 3031 Industry Reclaimed Rubber

Process Digester Process

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	million KWH	2.7			2.7	2.5			2.5
3	Residual fuel oil	million KWH	3.1			3.1	2.9			2.9
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	million KWH	36.3			36.3	33.8			33.8
8	Natural gas	million KWH	57.9			57.9	53.8			53.8
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased) (1)	million KWH	154.1			154.1	143.3			143.3
12	GRAND TOTAL	million KWH				254.1				263.3

(1) As fuel equivalents of electricity

EXHIBIT X-2-2b
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Units of Volume.(1)

SIC 3031 Industry Reclaimed Rubber

Process Pan Process (or Dry Process)

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	1,000 barrels	0.30			0.30	0.28			0.28
3	Residual fuel oil	1,000 barrels	0.35			0.35	0.33			0.33
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	1,000 short tons	1.0			1.0	0.9			0.9
8	Natural gas	billion cu. ft.	0.04			0.04	0.04			0.04
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	24.9			24.9	23.4			23.4
12	GRAND TOTAL									

Source: (1) Figures obtained by multiplying the production data of Exhibit X-5 by the energy factors of Exhibit X-6.

EXHIBIT X-2-3b
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billions BTUs.

SIC 3031 Industry Reclaimed Rubber

Process Pan Process (or "Dry" Process)

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates	billion BTUs	1.9			1.9	1.8			1.8
3	Residual fuel oil	billion BTUs	2.2			2.2	2.1			2.1
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	billion BTUs	25.7			25.7	24.1			24.1
8	Natural gas	billion BTUs	41.1			41.1	38.6			38.6
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	billion BTUs	263.8			263.8	247.8			247.8
12	GRAND TOTAL					334.7				314.4

EXHIBIT X-2-4b
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Million KWH Equivalents.

SIC 3031 Industry Reclaimed Rubber

Process Pan Process (or "Dry" Process)

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates	million KWH	0.6			0.6	0.6			0.6
3	Residual fuel oil	million KWH	0.6			0.6	0.6			0.6
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal	million KWH	7.5			7.5	7.0			7.0
8	Natural gas	million KWH	20.8			20.8	19.5			19.5
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased) (1)	million KWH	77.2			77.2	72.5			72.5
12	GRAND TOTAL	million KWH				106.7				100.2

(1) As fuel equivalents of electricity

EXHIBIT X-2-2c
FEO:USDC
REQUIRED TABLE 2

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Volume (1).

SIC 3031 Industry Reclaimed Rubber

Process Reclamator (or Mechanical)

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas									
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	million KWH	35.0			35.0	38.9			38.9
12	GRAND TOTAL	million KWH								

Source: (1) Figures obtained by multiplying the production data of Exhibit X-5 by the energy factors of Exhibit X-6.

EXHIBIT X-2-3c
FEO:USDC
REQUIRED TABLE 3

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in Billion BTUs.

SIC 3031 Industry Reclaimed Rubber

Process Reclamator (or Mechanical)

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971 Heat & Power	1971 Material	1971 Other	1971 Total	1973 Heat & Power	1973 Material	1973 Other	1973 Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas									
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased)	Billion BTUs	56			56	62			62
12	GRAND TOTAL	Billion BTUs				56				62

EXHIBIT X-2-4c
FEO:USDC
REQUIRED TABLE 4

Consumption and Use of Fuels, Petroleum Products, and Energy by Type and Major Process and Subprocess in KWH Equivalent.

SIC 3031 Industry Reclaimed Rubber

Process Reclamator (or Mechanical)

Subprocess

Line Number	Type of Energy or Material	Unit of Measure	1971				1973			
			Heat & Power	Material	Other	Total	Heat & Power	Material	Other	Total
1	Propane, butane and mixtures									
2	Middle distillates									
3	Residual fuel oil									
4	Chemical feedstocks									
5	Other petroleum products, total									
6	Petroleum products, total									
7	Coal									
8	Natural gas									
9	Fuels, n.e.c., total									
10	Other fuels, total									
11	Electrical energy (purchased) (1)	million KWH	109			109	121			121
12	GRAND TOTAL	Million KWH				109				121

(1) As fuel equivalents of electricity

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EXHIBIT X-2-5
FEO: USDC
REQUIRED TABLE 5

Industry Consumption of Fuels, Petroleum Products, and Energy by Type - 1971, 1973, and 1974

SIC 3031 Industry Reclaimed Rubber

Line No.	Type of Energy or Material	Unit of Measure	Volume			Bil. BTU's (3)			% Change		% of Total BTU's	
			1971(1)	1973(2)	1974(2)	1971	1973	1974	1971-73	1973-74	1971	1974
1	Propane, butane, and mixtures											
2	Middle distillates	1,000 barrels	5.8	5.6	5.6	33.6	32.7	33	(3.4)	(Z)	1.5	1.5
3	Residual fuel oil	1,000 barrels	6.2	6.0	6.0	38.4	37.4	37	(3.2)	(Z)	1.7	1.7
4	Chemical feedstocks											
5	Other petroleum, products, total											
6	Petroleum products, total											
7	Coal	1,000 short tons	17.3	16.8	16.8	453.3	441.1	440	(2.9)	(Z)	12.6	19.6
8	Natural gas	billion cu. ft.	0.7	0.7	0.7	722.4	722.4	720	(Z)	(Z)	31.3	31.3
9	Fuels, n.e.c. total											
10	Other fuels, total											
11	Electrical energy (purchased only)	million KWH	100	100	100	1060.0	1060.0	1100	(Z)	(Z)	45.9	45.9
12	GRAND TOTAL	(X)	(X)	(X)	(X)	2307.7	2300	2300	(Z)	(Z)	100.0	100.0

Source: (1) Census data from "Fuels and Electric Consumed", MC72(SR)-6.
(2) Snell estimates based on Exhibit X-5 data and the 1971 energy profile.
(3) BTUs and cu. ft. of natural gas have been changed to billions from millions.

EXHIBIT X-2-9
FEO: USDC
REQUIRED TABLE 9

Stocks of Fuels and Petroleum Products by Type, 12/31/73 and 3/31/74

SIC 3031 Industry Reclaimed Rubber

Line Number	Type of Energy or Material	Stocks (# of days supply related to average daily requirements in next quarter)					
		As of December 31			As of March 31		
		1971	1972	1973	1972	1973	1974
1	Propane						
2	Butane						
3	Propane Butane Mixture						
4	Middle Distillates	2	10	10	2	10	10
5	Residual Fuel Oil	6	6	8	7	8	9
6	Chemical Feedstocks						
7	Other Petroleum Products, total						
	. Process Oil	10	15	20	8	15	17
	. Solvent	2	3	6	2	10	100
	. Carbon Black	10	10	10	10	10	10
8	Coal	10	0	1	0	0	25
9	Natural Gas						
10	Fuels, n.e.c., total						

Source: One major rubber reclaimer. Data is illustrative, but statistically insufficient description of the industry.

EXHIBIT X-2-12
FEO: USDC
REQUIRED TABLE 12

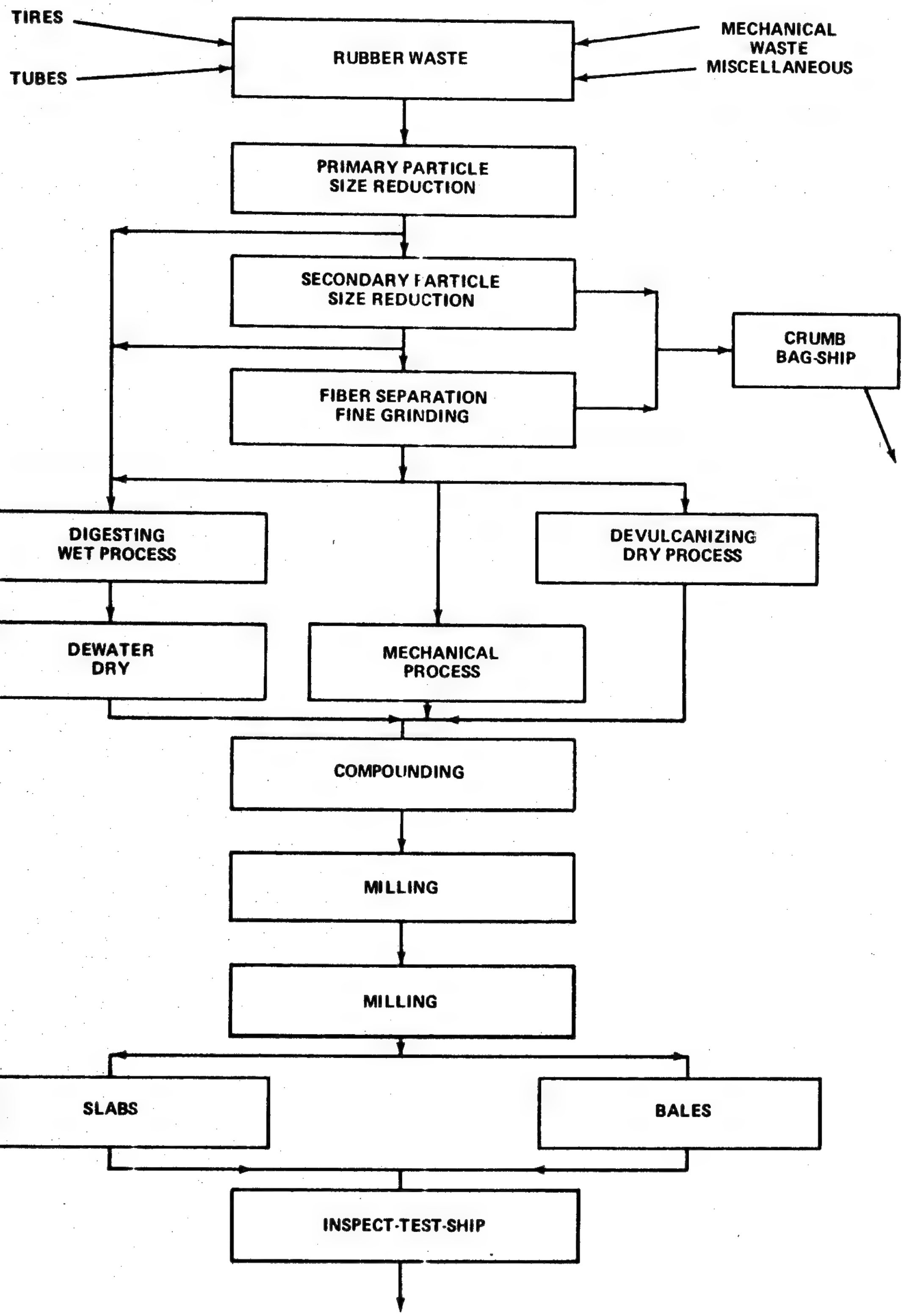
Seasonal Use of Fuels, Petroleum Products and Energy by Type, 1973

SIC 3031 Industry Reclaimed Rubber

Line Number	Type of Material or Energy	Percent of Annual Use in 1973 in			
		Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.
1	Propane, butanes and mixtures				
2	Distillates	45	15	10	30
3	Residual	38	19	14	29
4	Feedstocks				
	. Process Oil	27	33	16	24
	. Solvent	50	40	9	1
	. Carbon Black	26	24	19	31
5	Other petroleum products				
6	Coal				
7	Natural gas				
8	Other fuels				
9	Electrical Energy (purchased)	27	27	22	24

Source: One major rubber reclaimer. Data is illustrative but statistically insufficient description of the industry.

EXHIBIT X-3
FEO: USDC
RUBBER RECLAIMING PROCESS FLOW



Source: "Solid Waste Management in the Fabricated Rubber Products Industry, 1968," Rubber Re-use and Solid Waste Management Part I, U.S. Environmental Protection Agency, 1971, p. 57.

EXHIBIT X-4
FEO: USDC
SIC 3031 - VALUE OF SHIPMENTS - 1967, 1971-1974
(Dollars in Millions)

LINE	ITEM	1967	1971	1972	1973	1974 [6]
1.	Value of products and services sold by SIC 3031 industry[1]	$43.8	$32.1	$34.6	$31.3	$36.0
2.	Value of SIC 3031 products shipped by SIC 3031 industry[2]	35.4	30.5	33.1	29.9	34.4
3.	Value of SIC 3031 products shipped by all industries[3]	47.3	46.2	52.0	47.0	54.1
4.	Ratio of value of SIC 3031 products shipped by SIC 3031 industry to value of SIC 3031 products shipped by all industries (coverage ratio)[4]	0.75	0.66	0.64	0.64	0.64
5.	Value of SIC 3031 products from major processes shipped by SIC 3031 industry:[5]					
	Digester process	$19.9	$15.4	$16.2	$14.6	$16.8
	Pan process	11.7	9.0	9.5	8.5	9.8
	Reclamator process	3.8	6.1	7.4	6.8	7.8

Footnotes:

(1) Figures for 1967, 1971, and 1972 obtained from Sources (a) and (b). Figures for 1973 calculated from value given in line 2 using same ratio as in 1972.

(2) Figures calculated from values in line 3 using ratios given in line 4.

(3) Figures for 1967, 1971, and 1972 obtained from Sources (a), (c) and (b). Figures for 1973 calculated using quantity of shipments in 1973 calculated from data in Source (d) using formula, quantity of shipments in 1973 = quantity of production in 1973 + quantity in stock at end of 1972 - quantity in stock at end of 1973, and same price trend as determined for synthetic rubber.

(4) Ratios for 1967 and 1972, obtained from Sources (a) and (b). Ratio for 1971 obtained from straight line interpolation of 1967 and 1972 ratios. Ratio assumed to be constant for 1972 - 1974.

(5) Based on data presented in Exhibit X-4 assuming the prices for reclaimed rubber do not depend upon the product process and that the quantities shipped from each process are in the same proportions as the quantities produced.

(6) It is assumed that reclaimed rubber manufacturers will be allowed to increase their prices, but will not want to increase them the same amount as synthetic rubber prices. A 15% increase has been assumed here along with no increase in the quantity shipped.

Sources:

(a) "Industry Statistics," 1967 Census of Manufactures, U.S. Department of Commerce, Vol. II, Part 2, Major Groups 25-33, 1971, pp. 30A1-33.
(b) "Reclaimed Rubber, SIC 3031," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC72 (P)-30A-3, February 1974.
(c) "Value of Product Shipments," Annual Survey of Manufactures 1971, U.S. Department of Commerce, Publication M71 (AS)-2, October 1973.
(d) "Industry Rubber Report," Rubber Manufacturers Association, Inc., New York, N.Y., February 6, 1974.
(e) "Rubber: Supply and Distribution for the United States-Summary for 1972," Current Industrial Reports, U.S. Department of Commerce, Series: M30A (72)-13, December 1973.
(f) Telephone interview with Kenneth M. Stern, Gordian Associates, New York, N.Y., March 13, 1974.
(g) Telephone interview with Mr. Fitzgerald of the Rubber Reclaimers Association, March 14, 1974.

EXHIBIT X-5
FEO: USDC

SIC 3031 - PRODUCTION VOLUME - 1967, 1971-1974
(Pounds in Millions)

LINE	ITEM	1967	1971	YEAR 1972	1973	1974 [6]
1.	Total production by SIC 3031 industry [1]	516.7	304.5	284.7	294.3	294.3
2.	Total production of SIC products by SIC 3031 industry [2]	417.6	289.3	272.3	281.5	281.5
3.	Total production of SIC 3031 products by all industries [3]	558.0	438.2	427.8	442.2	442.2
4.	Ratio of production of SIC 3031 products by SIC 3031 industry to production of SIC 3031 products by all industries [4]	0.75	0.66	0.64	0.64	0.64
5.	Production of SIC 3031 products by major processes by SIC 3031 industry [5]					
	Digester process	235.2	146.2	133.5	137.2	137.2
	Pan process	137.8	85.7	78.2	80.5	80.5
	Reclamator process	44.6	57.4	60.6	63.8	63.8

Footnotes:

(1) Figures given in "equivalent" production of SIC 3031 products calculated from figures in line 2 by applying ratio of the total value of SIC 3031 products and services sold by SIC 3031 industry to the value of SIC 3031 products shipped by the industry (see Exhibit X-3).

(2) Figures calculated from quantities in line 3 using ratios given in line 4.

(3) Figures for 1967 obtained from Source (a), for 1971 and 1972 from Source (b), and for 1973 from Source (c).

(4) Ratios are those which were established for the values of shipments for this industry (see Exhibit X-3).

(5) Based on data obtained from Source (d) that production mix in 1967 was about 58% Digester, 34% Pan, and 8% Reclamation and information from Source (e) that Reclamator process is used by only one firm which has increased its production over the years to around the quantity indicated in 1973 (linear interpolation used to estimate 1971 and 1972 Reclamator figures. It is assumed that the relative production volumes from the Digester and Pan process has remained constant over these years.

(6) Figures for 1974 based upon information from Source (e) is that all reclaimed rubber producers are presently operating at their fully utilizable capacities and that no new production capacity is planned for 1974.

Sources:

(a) "Industry Statistics," 1967 Census of Manufactures, U.S. Department of Commerce, Vol. II, Part 2, Major Groups 25-33, 1971, pp. 30A1-33.
(b) "Rubber: Supply and Distribution for the United States - Summary for 1972," Current Industrial Reports., U.S. Department of Commerce, Series: M30 A(72)-13, December 1973.
(c) "Industry Rubber Report," Rubber Manufacturers Association, Inc., New York, N.Y., February 6, 1974.
(d) Telephone interview with Kenneth M. Stern, Gordian Associates, New York, N.Y., March 13, 1974.
(e) Telephone interview with Mr. Fitzgerald of the Rubber Reclaimers Association, March 14, 1974.

EXHIBIT X-6
FEO: USDC
SIC 3031 - ENERGY FACTORS FOR INDUSTRY AND MAJOR PROCESSES - PRESENT STATUS OF THE ARTS
(Per Million Pounds Produced)

Process	REQUIREMENTS (1)								
	Middle Distillates	Residual Fuel Oil	Coal	Natural Gas	Fuel Equivalent	Electricity		Total Equivalent	
	(1000 barrels)	(1000 barrels)	(1000 Short Tons)	(billion Cu. Ft.)	(billion BTUs)	(million KWH)	(billion BTUs)	(billion BTUs)	(million KWH)
Average for SIC 3031 (2) from Census	0.019	0.020	0.057	0.0023	4.1	0.34	3.48	7.6	2.23
Digester Process (3)	0.011	0.012	0.032	0.0014	1.5	0.35	3.8	5.3	1.55
Pan Process (3)	0.00035	0.00041	0.012	0.00047	0.9	0.29	3.1	4.0	1.17
Reclamator (3)	(Z)	(Z)	(Z)	(Z)	(Z)	0.61	6.5	6.5	1.90

(1) The various fuels are allocated to the processes in the same ratios as in the whole industry in 1971, shown in Exhibit X-2-5.
(2) Census data, from "Fuel and Electric Energy Consumed" MC72(SR)-6, divided by total production figures from Line 1 of Exhibit X-5.
(3) Source: Gordian Associates, Rubber Reclaimers Association and Snell estimates.

SECTION XI

SIC 3069, FABRICATED RUBBER PRODUCTS N.E.C.

(Covering SIC 3069 plus SIC 3041 by the 1972 census definition, which is the same as SIC 3069 by the 1967 census definition)

Exhibit XI-1 at the end of this section presents a detailed industry definition. In 1971 value added by manufacture was $2,003 million according to the Annual Survey of Manufactures, while value of shipments was $3,495 million and total gross book value of depreciable assets was $1,498 million. The same source reports energy consumption of 13.1 billion KWH equivalents. County Business Patterns, 1972, reports that about 1,100 establishments were classified in SIC 3069.

The most important findings follow regarding the economic impact of the petroleum based materials shortages during 1973 and the first quarter of 1974:

- Fuel shortages were of concern to the industry, but have not caused serious disruptions.
- Raw material shortages have been a problem with more than half of the firms not able to obtain sufficient supplies of materials, with neoprene particularly singled out.
- Employment was not significantly affected although no appreciable gains were projected for 1974.
- No major near-term opportunities for substitutions or conservation of fuels were identified.
- There are significant differences in the energy requirement of the major equipment for processing rubbers.

Exhibit XI-2, following Exhibit XI-1, features the Required Tables. These tables and supporting exhibits further define the industry's structure both in economic and energy terms.

All exhibits appear sequentially at the end of this section. Whenever electricity KWHs are expressed as BTUs, conversion is based on the nominal fuel requirements to generate the electricity.

1. MAJOR USES OF FUELS, ENERGY, AND PETROLEUM PRODUCTS

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

1.1 Task I, Major Processes

As of the 1967 census, SIC 3069 industry included 102 subclassifications distributed among 10 subcategories. It is in effect, a catchall classification, based on product type. Major divisions include the following:

- Rubber and Plastic Belt and Belting
- Rubber Hose and Tubing
- Sponge and Foam Rubber Goods
- Rubber Floor and Wall Covering
- Mechanical Rubber Goods
- Rubber Heels and Soles
- Druggist and Medical Sundries
- Other Rubber Goods

The two most significant categories are "Mechanical Rubber Goods" and "Other Rubber Goods" and together these accounted for 55.4% of the value of shipments in 1967.

This classification does not lend itself to a manageable study from the standpoint of technically similar processes. Products resulting from entirely different technologies are often lumped into the same subcategory. Units of production vary from pounds to pairs to square feet, or to yards.

The table below provides Snell's estimates of energy required in some basic unit operations of the industry, which can be found in the production of a variety of products.

Energy Requirements - Per Pound of Material Processed

Operation	Electricity (KWH)	Heat (BTUs)	Total (BTUs)
Banbury	0.13	350	1750
Calender	0.24	300	2850
Extruder	0.14	150	1650
Curing Press	0.02	2500	2700

However, meaningful use of these factors is not possible within the time frame and level of effort of this study. The relative utilization of the equipment, or even the appropriate quantification of the production parameters, cannot be calculated on the basis of readily available general data describing the industry.

1.2 Task II, Industry Output

Exhibit XI-3 shows value of shipments for 1967 and 1971 to 1974. In 1973 this was $4,250 billion. Production quantities were not estimated because of the great dissimilarity of products and the extensive use of non-rubber materials in some products. Exhibit XI-2-1 presents Required Table 1.

1.3 Task III, Energy Related Profile of Major Processes

No energy profiles were developed for major processes for the reasons indicated under 1.1 above.

1.4 Task IV, Shifts in The Energy Related Profile of The Industry - 1971 to 1973

Meaningful energy factors based on production quantities could not be developed. Therefore, these were estimated using 1967 and 1972 census data as a function of 1967 dollar value of shipments. Exhibit XI-4 presents the energy factors and shows an increase in the BTU per constant dollar requirement from about 18 billion BTUs per 1967 dollars in 1967 to about 26 billion BTUs per 1967 dollars in 1973.

Exhibit X-2-5 presents Required Table 5 and indicates an approximately 25% increase in energy requirement from about 70,000 billion BTUs in 1971 to about 88,000 billion BTUs in 1973. Purchased electricity is the principal energy source, accounting for over 40% of BTU needs.

1.5 Task V, Projected 1974 Energy Related Profile of The Industry

The projected 1974 energy requirement is about 90,000 billion BTUs, up 2.7% from 1973.

2. GEOGRAPHIC PATTERN OF USE

The principal outputs from the tasks of this subsection are "Required Tables" and analysis of findings.

2.1 Task I, Geographic Pattern of the Industry's Energy Related Profile - 1971 to 1973

Exhibits XI-2-6 and 7 present the estimated geographic distribution of SIC 3069 industry's energy needs for 1971 and 1973, respectively. The fabrication of rubber products is widely distributed geographically. There is a significant concentration of manufacture in the East North Central states, accounting for about 40% of the 1973 energy requirements.

2.2 Task II, Geographic Pattern of Employment and Shipments

Exhibit XI-2-8 presents the Required Table showing from 1971 to 1973:

- a 20% increase in value of shipments nationally
- a 9% employment increase nationally
- a 25% increase in BTU requirements nationally
- employment declines and below average growth in shipments in the Middle Atlantic states
- average and above average gains in shipments, employment and BTU requirements in the East North Central states

2.3 Task III, Shifts in the Patterns

These are listed above.

3. FUEL AND ENERGY SUPPLY SITUATION

The principal outputs from the tasks of this subsection are analysis of findings.

3.1 Task I, "Normal" Stocks of Materials

Industry interviews indicated the following illustrative responses regarding definition of "normal" stocks of materials: 30 days' supply of residual fuel oil; 30 days of phthalates; 60 days of solvents; 30 to 150 days of reclaimed rubber; 30 days of SBR.

3.2 Task II, Shifts in Stocks

The respondents noted that during 1973 and the first quarter of 1974 reduction in fuel oil stocks has not been a major problem. Shortages of plasticizers, solvents and some rubbers such as neoprene were singled out. Data is not sufficiently quantified to present Required Table 9.

3.3 Task III, Captive Use

In 1967 less than 3% of the electricity used was captively generated. Industry interviews indicate that captive production of fuels is negligible. Therefore, Required Table 10 is not pertinent.

3.4 Task IV, Sources of Supply

Small and medium sized establishments purchase fuel oil from retailers and wholesalers, while larger firms sometimes purchase from refineries. Natural gas and electricity is obtained from utilities.

3.5 Task V, Proportion by Type of Supplier

Required Table 11 is not available since the information is not sufficiently quantified.

3.6 Task VI, Seasonality of Use

Taken as a whole, the industry operates at full capacity, year round. Winter use of fuels is reported to be slightly higher than summer use due to heating requirements, while summer use of electricity is higher than winter use due to cooling needs. Required Table 12 is not available since these trends are insufficiently quantified.

4. SUBSTITUTABILITY AND CONSERVATION OF MAJOR FUELS AND PETROLEUM PRODUCTS

The findings in this section were developed through industry interviews, review of secondary sources, and review of in-house information.

4.1 Task I, Major Processes

Interview respondents did not express optimism regarding extensive raw materials substitution, although some claimed research efforts in this area. No significant opportunity was noted for substituting coal for oil or natural gas. Energy economy in processing could not result in greater than 5% saving according to some.

4.2 Task II, Quantification of The Major Substitutability and Conservation Opportunities

Use of rubber chemicals to conserve energy has been suggested, according to Rubber World, January 1974:

> "For instance: to cut processing time and thus conserve energy, use ultra-accelerators to effect vulcanization. This step, however, would necessitate a change in the processing system.
>
> In rubber breakdown, equipment may do the job. But if ½ - ¼% of peptizer were added to the compound, power requirements and breakdown time could be reduced, the latter as much as 50%, according to one source.
>
> Rubber chemical dispersions help conserve energy by eliminating extra mixing cycles, shortening mixing cycles, reducing cure time.
>
> In the finishing process one producer crushes instead of pelletizing, thus consuming less energy."

4.3 Task III, Principal Constraints

The principal constraints to raw material substitution during 1973 and the first quarter of 1974 was the general lack of availability of most petroleum-based materials. The principal substitution mode can be characterized as "trading-up", substituting with higher priced materials.

4.4 Task IV, Plant Level Operating Characteristics

The production of rubber products is primarily dependent upon supply of raw materials or fuels to generate the power to operate the production machinery.

- The output of rubber products is directly proportional to the supply of raw material.
- The output of rubber products is essentially directly proportional to the supply of energy for the operation of the necessary machinery.
- Due to the high cost of machinery in a rubber products plant, these faciltiies must be operated at 75-85% of capacity to turn a profit.

4.5 Task V, Capital Stock (1973)

The 1973 gross book value of fixed assets was about $1.75 billion. This estimate is based on the following:

- The 1971 Annual Survey of Manufactures indicates that gross book value of fixed assets was $1,498 million at the end of 1971.
- According to the same source, capital expenditures in 1972 were $118 million.
- In 1971, capital expenditures of $90 million were needed to offset retirements of capital goods.

- Assuming at least $1 of capital expenditure is required per 1967 dollar of shipments, an additional $220 of capital assets needed to have been added in 1973.

At $1 of capital expenditure per 1967 dollar of shipments, the replacement value of present capital assets of the industry is about $3.4 billion.

4.6 Task VI, Planned Capital Investment (1974)

Historical growth in the indsutry would have indicated an increase in value shipments in 1967 dollars of $186 million from 1973 to 1974. This would require a capital investment of about $300 million. This estimate is supported by the statement of some of the firms interviewed that there were major plans for capital investment in 1974.

4.7 Task VII, Changes to Investment Plans

Some firms who have been hit hardest by the shortages have cancelled their investment plans. Those firms not affected are apparently going ahead with their investments in the short term. If it is assumed that the growth in value of shipments in 1967 dollars in 1975 is half that originally planned, capital investment in 1974 can be expected to run about $200 million.

5. INTRA-INDUSTRY EFFICIENCY

The findings in this section were developed through the use of industry interviews, review of secondary sources, and review of in-house information.

5.1 Task I, Energy Efficiency

The rubber products industry has taken steps to conserve energy; energy conservation measures have included:

- decrease in plant lighting
- lowering and locking of thermostats
- more efficient scheduling of deliveries by company owned vehicles
- one respondent purchased an auxiliary boiler for plant heating in order that the large boilers used in manufacturing processes be shut down on weekends.

These and similar efforts probably have not enhanced energy efficiency by more than 5%.

5.2 Task II, Major Factors Affecting Efficiency

The variations in energy efficiency as a function of plant size, age, equipment type, and product line can be substantial.

6. PRINCIPAL CONSTRAINTS ON CURRENT INDUSTRY OPERATIONS

The findings in this section were developed through industry interviews, review of secondary sources, and in-house information.

6.1 Task I, Important Constraints

The Snell interviews during February 1974 indicated concern with shortages of petroleum-based raw materials, with the inability to plan, regarding prices and evidence of work interruptions due to lack of gasoline for employee vehicles, particularly in the Eastern United States. No indications were found of significant reduction in industry-wide employment, although some respondents reported layoff plans in case of persistent shortages.

6.2 Task II, Most Serious Constraints

The most serious constraint identified is potential raw material shortages. A purchasing agents' survey reported by *Rubber World* in January 1974 showed the following:

Status On Raw Materials

	Ample	Short	Allocation
Natural Rubber	66%	7%	7%
Synthetic Rubber	23	31	62
Carbon Black	56	13	11
Process Oil	30	33	30
Accelerators/Activators	47	33	31
Zinc Oxide	21	47	43
Stearic (fatty) Acid	34	36	26
Antioxidants/Antiozonants	49	30	13
Other	--	*	**

Source: *Rubber World*, January 1974

6.3 Task III, Shortfalls in Supply and Price Increase

The Snell interviews during February 1974 indicated 5% to 10% general shortfall in the supply of petroleum-based raw materials. Neoprene was singled out as a particularly scarce commodity. Shortfalls in fuel supply were not expected to be as problematic as those of raw materials.

Severe price increases in raw materials were projected for 1974, 8% per month during the first half of 1974, according to one respondent.

Expected changes in output during 1974 were generally toward increased production.

Some respondents noted that during 1974 several marginal establishments and small businesses will "fold" as a direct or indirect result of the shortages.

6.4 Task IV, Outputs Critical to Subsequent Production

The outputs of this industry are used in many facets of the economy. Some uses include:

- Industry:
  - rubber hoses
  - fatigue mats
  - machine cushions (sound absorbers)
  - protective clothing
- Transportation
  - rubber hoses
  - protective clothing
  - machine cushions
  - protective covers for machines
- Quality of Consumer Life:
  - toys
  - rainwear
  - sporting equipment
  - rubber hoses

EXHIBIT XI -1 (1)
FEO: USDC
DEFINITION OF SIC 3069,
INCLUDING THE NEWLY
DEFINED SIC 3041[1]

SIC 3069 FABRICATED RUBBER PRODUCTS, NOT ELSEWHERE CLASSIFIED

Establishments primarily engaged in manufacturing industrial and mechanical rubber goods, rubberized fabrics and vulcanized rubber clothing, and miscellaneous rubber specialties and sundries. Establishments primarily engaged in rebuilding and retreading tires are classified in Industry 7534; and gaskets and packing in Industry 3293.

Acid bottles, rubber
Air supported rubber structures
Aprons, vulcanized rubber and rubberized fabric: mitse
Bags, rubber or rubberized fabric
Balloons, advertising and toy: rubber
Balloons, metal foil laminated with rubber
Balls, rubber: except baseballs, basketballs, footballs, golf and tennis
Bath sprays, rubber
Bathing caps and suits, rubber
Battery boxes, jars, and parts: hard rubber
Bibs, vulcanized rubber and rubberized fabric: mitse
Bottles, rubber
Boxes, hard rubber
Brake lining, rubber
Brushes, rubber
Bulbs for medicine droppers, syringes, atomizers, sprays: rubber
Bushings, rubber
Capes, vulcanized rubber and rubberized fabric: mitse
Caps, rubber
Castings, rubber
Chlorinated rubbers, natural
Cloaks, vulcanized rubber and rubberized fabric: mitse
Clothing, vulcanized rubber and rubberized fabric: mitse
Combs, hard rubber
Culture cups, rubber
Cyclo rubbers, natural
Dress shields, vulcanized rubber and rubberized fabric: mitse
Druggists' sundries, rubber
Erasers: rubber or rubber and abrasive combined
Fabrics, rubberized
Finger cots, rubber
Flooring, rubber: tile or sheet
Foam rubber
Fountain syringes, rubber
Friction tape, rubber
Fuel tanks, collapsible: rubberized fabric
Funnels, rubber
Gloves: surgeons', electricians', household, etc. -- rubber
Grips and handles, rubber
Grommets, rubber
Gutta percha compounds
Hair curlers, rubber
Hairpins, rubber
Handles, rubber
Hard rubber products
Hard surface floor coverings: rubber
Heels, boot and shoe: rubber, composition, and fiber
Jar rings, rubber
Laboratory sundries: cases, covers, funnels, cups, bottles, etc. -- rubber
Latex, foamed
Life jackets: inflatable, rubberized fabric

EXHIBIT XI -1 (2)
FEO: USDC
DEFINITION OF SIC 3069,
INCLUDING THE NEWLY
DEFINED SIC 3041

Life rafts, rubber
Liner strips, rubber
Mallets, rubber
Mats and matting: bath, door, etc. - rubber
Mattress protectors, rubber
Mattresses, pneumatic: fabric coated with rubber
Medical sundries, rubber
Mittens, rubber
Molded rubber products
Mouthpieces for pipes, cigarette holders, etc. - rubber
Nipples, rubber
Orthopedic sundries, molded rubber
Pacifiers, rubber
Pads, kneeling: rubber
Pants, baby: vulcanized rubber and rubberized fabric - mitse
Pillows, sponge rubber
Pipestems and bits, tobacco: hard rubber
Platens, except printers': solid or covered rubber
Plumbers' rubber goods
Pontoons, rubber
Pump sleeves, rubber
Rods, hard rubber
Rolls, except printers': solid or covered rubber
Rubber bands
Rubber covered motor mounting rings (rubber bonded)
Rubber heels, soles, and soling strips
Rug backing compounds, latex
Separators, battery: rubber
Sheeting, rubber or rubberized fabric
Sheets, hard rubber
Sleeves, pump: rubber
Soles, boot and shoe: rubber, composition and fiber
Soling strips, boot and shoe: rubber, composition, and fiber
Spatulas, rubber
Sponge rubber and sponge rubber products
Stair treads, rubber
Stationers' sundries, rubber
Stoppers, rubber
Teething rings, rubber
Thermometer cases, rubber
Thread, rubber: except fabric covered
Tile, rubber
Top lift sheets, rubber
Top roll covering, for textile mill machinery: rubber
Toys, rubber
Trays, rubber
Tubing, rubber
Type, rubber
Urinals, rubber
Valves, hard rubber
Wainscoting, rubber
Washers, rubber
Water bottles, rubber
Weather strip, sponge rubber
Wet suits, rubber

Source: 1972 Standard Industrial Classification Manual

(1) The 1972 census definition of SIC 3069 plus the 1972 census definition of SIC 3041 are essentially the same as the 1967 census definition of SIC 3069. Thus, this sector was studied relative to the 1967 census definition.

EXHIBIT XI -1 (3)
FEO: USDC
DEFINITION OF SIC 3069,
INCLUDING THE NEWLY
DEFINED SIC 3041 (1)

SIC 3041 RUBBER AND PLASTICS HOSE AND BELTING

Establishments primarily engaged in manufacturing rubber and plastics hose and belting, including garden hose. Establishments primarily engaged in manufacturing rubber tubing are classified in Industry 3069; plastic tubing in Industry 3079; and flexible metallic hose in Industry 3599.

Air brake and air line hose, rubber or rubberized fabric
Automobile hose, plastics
Automobile hose, rubber
Belting: conveyor, elevator, transmission, etc. - rubber
Fire hose, rubber
Garden hose, plastics
Garden hose, rubber
Heater hose, plastics
Heater hose, rubber
Hose: cotton fabric, rubber lined
Pneumatic hose: air brake, air line, etc. - rubber or rubberized fabric
Vacuum cleaner hose, plastics
Vacuum cleaner hose, rubber
V-belts, rubber or plastics

Source: 1972 Standard Industrial Classification Manual

(1) The 1972 census definition of SIC 3069 plus the 1972 census definition of SIC 3041 are essentially the same as the 1967 census definition of SIC 3069. Thus, this sector was studied relative to the 1967 census definition.

EXHIBIT XI-2-1
FEO:USDC
REQUIRED TABLE 1

Proportion of Industry Output Accounted for by Each Major Process, 1973

SIC 3069 Industry Fabricated Rubber Products, N.E.C.
(including Rubber and Plastics Hose and Belting, SIC 3041)

Process and Major Products	Percent of 1973 Shipments Value	Percent of 1973 Production Volume 1/
Rubber and plastics belts and belting	8.6%	8.6%
Rubber hose and tubing	13.9	13.9
Sponge and foam rubber goods	7.3	7.3
Rubber floor and wall covering	2.1	2.1
Mechanical rubber goods, n.e.c.	27.2	27.2
Rubber heels and soles	2.9	2.9
Druggist and medical sundries	2.8	2.8
Other rubber goods, n.e.c.	11.0	11.0
Fabricated rubber products, n.e.c., n.s.k.	3.9	3.9
Secondary products and miscellaneous receipts	20.3	20.3
Total Industry (Percent)	100.0	100.0
(Actual)	$4,250,000,000	$3,373,000,000

1/ Production volume expressed in terms of value of shipments in 1967 dollars.

Source: Exhibit XI-3.

EXHIBIT XI-2-5
FEO: USDC
REQUIRED TABLE 5

Industry Consumption of Fuels, Petroleum Products, and Energy by Type - 1971, 1973, and 1974

SIC 3069 Industry Fabricated Rubber Products, N.E.C.

Line No.	Type of Energy or Material	Unit of Measure	Volume (1)			Bil. BTU's *			% Change		% of Total BTU s	
			1971	1973	1974	1971	1973	1974	1971-73	1973-74	1971	1974
1	Propane, butane, and mixtures											
2	Middle distillates	1000 barrels	692.3	940	970	4,000	5,400	5,500	35.0	1.9	5.7	6.2
3	Residual fuel oil	1000 barrels	1264.3	1,520	1,560	7,900	9,400	9,700	19.0	3.2	11.3	10.7
4	Chemical feedstocks											
5	Other petroleum, products, total											
6	Petroleum products, total											
7	Coal	1000 short tons	331.1	270	280	8,700	7,100	7,300	(18.4)	2.8	12.4	8.3
8	Natural gas	billion cu. ft.	19.9	28.7	29.5	20,500	29,700	30,500	44.9	2.7	29.2	33.0
9	Fuels, n.e.c. total											
10	Other fuels, total											
11	Electrical energy (purchased only)	million KWH	2700	3,400	3,500	29,100	36,100	37,100	24.1	2.8	41.5	41.2
12	GRAND TOTAL		X	X	X	70,200	87,700	90,100	24.9	2.7	100%	100%

* BTU s and Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Source: (1) Value of shipments in 1967 dollars on Line 6 of Exhibit XI-3 multiplied by energy factors from Exhibit XI-4. The 1973 energy factors were used for "High" and "Low" average shipments in 1974.

EXHIBIT XI - 2-8 a
FEO:USDC
REQUIRED TABLE 8

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit (1)

SIC 3069 Industry Fabricated Rubber Products, N.E.C. Year 1971

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU's)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU's)*	Total (Bil. BTU's)*	Purchased Electrical Energy (Bil. BTU's)*	Grand Total (Bil. BTU's)*
1	United States		692	1,264			11,900	331	20		29,200	29,100	70,200
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.		58.9	106			990	29.6	1.7		2,440	2,400	5,850
8	R.I.		17.3	31.5			295	8.8	0.5		730	710	1,740
9	Conn.		23.4	42.7			395	12.3	0.7		990	970	2,350
10	Middle Atlantic												
11	N.Y.		18.3	33.6			315	9.4	0.6		780	760	1,870
12	N.J.		45.7	81.4			765	22.5	1.3		1,900	1,860	4,530
13	Penn.		35.6	64.1			600	18.4	1.1		1,490	1,450	3,550
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio		167	300			2,810	83.8	4.9		7,000	6,840	16,640
17	Ind.		52.8	95.6			900	26.6	1.6		2,240	2,190	5,320
18	Ill.		33.3	61.0			570	17.4	1.0		1,420	1,380	3,320
19	Mich.		25.4	46.8			435	13.3	0.8		1,080	1,060	2,570
20	Wisc.		5.7	10.2			97	2.9	0.2		240	230	570
21	W. North Central												
22	Minn.												
23	Iowa												
24	Mis.		11.2	20.3			190	5.6	0.3		475	460	1,130
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU's & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

		Petroleum Products						Other Fuels					
Line Number	Geographic Unit	Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.		53.9	9.8			90	2.8	0.2		230	220	540
33	D.C.												
34	Va.		18.3	32.5			305	9.2	0.5		760	740	1,820
35	W. Va.		3.3	5.9			55	1.6	0.1		140	130	330
36	N.C.		14.2	25.4			235	7.0	0.4		585	570	1,380
37	S. C.												
38	Ga.		12.2	21.4			200	6.0	0.4		500	490	1,190
39	Fla.												
40	S.Central												
41	Ky												
42	Tenn.												
43	Ala.												
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas												
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah		2.1	3.9			35	1.1	0.1		90	90	210
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT XI - 2-6 c

		Petroleum Products						Other Fuels					
Line Number	Geographic Unit	Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
59.	Pacific												
60	Wash.		1.1	1.9			20	0.5			45	44	110
61	Ore.												
62	Cal.		36.6	65.1			610	18.4	1.1		1,520	1,480	3,600
63	Alas.												
64	Haw.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

(1) BTU distribution from Exhibit XI - 2-8 distributed according to the national pattern of Exhibit XI - 2-5. It should be noted that all "(NA)" have been left out of this table, but their locations are given in Exhibit XI-2-8.

EXHIBIT XI - 2-7 a
FEO: USDC
REQUIRED TABLE 7

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit (1)

SIC 3069 Industry Fabricated Rubber Products, N.E.C. Year 1973

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
1	United States		940	1,520			148,000	270	28.7		36,800	36,100	87,700
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.												
6	Vermont												
7	Mass.		67	133			1,130	20	2.0		2,790	2,730	6,650
8	R.I.		22	44			374	6.6	0.7		925	900	2,200
9	Conn.		29	57			485	8.6	0.9		1,195	1,120	2,850
10	Middle Atlantic												
11	N.Y.		20	41			348	6.1	0.6		860	840	2,050
12	N.J.		54	108			917	16	1.6		2,265	2,210	5,390
13	Penn.		38	77			650	12	1.2		1,605	1,570	3,830
14	NORTH CENTRAL												
15	E. North Central												
16	Ohio		196	392			3,334	59	5.9		8,240	8,040	19,613
17	Ind.		78	155			1,320	23	2.3		3,260	3,180	7,770
18	Ill.		43	87			737	13	1.3		1,820	1,180	4,340
19	Mich.		32	64			542	10	1.0		1,340	1,310	3,190
20	Wisc.		7.4	15			126	2.2	0.2		310	300	740
21	W. North Central												
22	Minn.												
23	Iowa												
24	Mis.		15	29			248	4.4	0.4		615	600	1,460
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.		6.6	13			112	2.0	0.2		275	270	660
33	D.C.												
34	Va.		22	45			378	6.7	0.7		935	910	2,220
35	W. Va.		2.9	5.9			50	0.9			125	120	290
36	N.C.		19	39			329	5.8	0.6		815	290	1,930
37	S. C.												
38	Ga.		14	28			238	4.2	0.4		590	570	1,400
39	Fla.												
40	S.Central												
41	Ky												
42	Tenn.												
43	Ala.												
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas												
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah		3.0	5.9			50	0.9			125	120	300
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT XI - 2-7 c

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Petroleum Products: Distillates (Thousand Barrels)	Petroleum Products: Residual (Thousand Barrels)	Petroleum Products: Feedstocks (Thousand Barrels)	Petroleum Products: Other (Thousand Barrels)	Petroleum Products: Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Other Fuels: Natural Gas (Bil. Cu. Ft.)*	Other Fuels: Fuels n.e.c. (Bil. BTU s)*	Other Fuels: Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
59	Pacific												
60	Wash.		0.8	1.6			13	0.2			35	30	790
61	Ore.												
62	Cal.		46	92			783	14	0.1		1,935	1,890	4,600
63	Alas.												
64	Haw.												

* BTU's & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

(1) BTU distribution from Exhibit XI - 2-8 distributed according to the national pattern of Exhibit XI - 2-5. It should be noted that all "(NA)" have been left out of this table but their locations are given in Exhibit XI - 2-8.

EXHIBIT XI-2-8a
FEO:USDC
REQUIRED TABLE 8

Shipments, Employment, and Fuels and Energy Consumed by Geographic Unit, 1971 and 1973

SIC 3069 Industry Fabricated Rubber Products, N.E.C.

Line Number	Geographic Unit	Value of Shipments ($ Millions) 1971(1)	1973(4)	% Change	Employment 1971(2)	1973(3)	% Change	Fuels and Energy Bil. ~~Mil.~~ BTU s 1971	1973	% Change
1	United States	3,552	4,250	20	135,800	148,000	9.0	70,200	87,700	25
2	NORTH EAST	(NA)								
3	New England	(NA)								
4	Maine	(NA)								
5	N.H.	(NA)								
6	Vermont	(NA)								
7	Mass.	264	262	(0.7)	11,300	11,270	(0.3)	5,850	6,650	14
8	R.I.	(NA)			3,360	3,730	11	1,740	2,200	26
9	Conn.	121	140	16	4,520	4,830	6.9	2,350	2,850	21
10	Middle Atlantic	491	491	0	19,680	19,095	(0.5)	9,950	11,270	13
11	N.Y.	101	93	(7.9)	3,600	3,470	(3.6)	1,870	2,050	10
12	N.J.	241	266	10	8,740	9,140	4.6	4,530	5,390	19
13	Penn.	149	132	(11)	6,850	6,485	(5.3)	3,550	3,830	8
14	NORTH CENTRAL	(NA)								
15	E. North Central	1,444	1,765	22	54,965	60,390	9.9	28,420	35,650	25
16	Ohio	860	927	7.7	32,120	33,240	3.5	16,640	19,610	18
17	Ind.	281	456	62	10,280	13,160	28	5,320	7,770	46
18	Ill.	177	228	29	6,505	7,350	13	3,320	4,340	31
19	Mich.	98	118	20	4,960	5,405	9.0	2,570	3,190	24
20	Wisc.	28	36	29	1,100	1,235	12	570	740	30
21	W. North Central	(NA)								
22	Minn.	(NA)								
23	Iowa	(NA)								
24	Mis.	(NA)								
25	N.D.	(NA)			2,170	2,470	14	1,130	1,460	29
26	S.D.	(NA)								
27	Neb.	(NA)								
28	Kans.	(NA)								

EXHIBIT XI-2-8b

Line Number	Geographic Unit	Value of Shipments ($ Millions) 1971	Value of Shipments ($ Millions) 1973	Value of Shipments % Change	Employment 1971	Employment 1973	Employment % Change	Fuels and Energy Bil. (~~Mil.~~ BTU s) 1971	Fuels and Energy 1973	Fuels and Energy % Change
29	SOUTH	(NA)								
30	S. Atlantic	(NA)								
31	Del.	(NA)								
32	Md.	(NA)			1,045	1,115	6.5	540	655	21
33	D.C.	(NA)								
34	Va.	(NA)			3,510	3,770	7.4	1,820	2,220	22
35	W. Va.	(NA)			630	500	(21)	330	295	(11)
36	N.C.	73	109	50	2,685	3,275	22	1,380	1,930	40
37	S.C.	(NA)								
38	Ga.	87	94	8	2,295	2,375	3.5	1,190	1,400	18
39	Fla.	(NA)								
40	S. Central	(NA)								
41	Ky.	(NA)								
42	Tenn.	85								
43	Ala.	(NA)								
44	Miss.	(NA)								
45	Ark.	(NA)								
46	La.	(NA)								
47	Okla.	(NA)								
48	Texas	(NA)								
49	WEST	(NA)								
50	Mountain	(NA)								
51	Mont.	(NA)								
52	Idaho	(NA)								
53	Wyo.	(NA)								
54	Colo.	(NA)								
55	N.M.	(NA)								
56	Ariz.	(NA)								
57	Utah	(NA)			420	500	19	210	295	40
58	Nev.	(NA)								

Line Number	Geographic Unit	Value of Shipments ($ Millions)			Employment			Fuels and Energy Bil. (~~Mil~~ BTU s)		
		1971	1973	% Change	1971	1973	% Change	1971	1973	% Change
59	Pacific	(NA)								
60	Wash.	(NA)			210	155	(25)	110	80	(27)
61	Ore.	(NA)								
62	Cal.	170	215	27	6,965	7,800	12	3,600	4,600	28
63	Alas.	(NA)								
64	Haw.	(NA)								

Source: (1) "Annual Survey of Manufactures," 1971; adjusted by factor of 1.016 to reflect the 1972 census redefinition of the industry, but including SIC 3041.
(2) "County Business Patterns (CBP)," 1971; adjusted as in (1).
(3) The Bureau of Labor Statistics (BLS) reports 170,000 total U.S. employment in 1971; 178,400 in 1972; and 190,900 in 1973. The 1972 to 1973 percent change in the BLS total employment figures was applied to the total U.S. and geographic employment figures from CBP, 1972, to obtain the 1973 estimates. CBP provides more regional data than BLS; adjusted as in (1).
(4) Total U.S. value of shipments is from Line 1, Exhibit XI-3. The regional values were estimated using an employment related change factor. For each percent change in the U.S. total employment a 2.22% change occurred in the U.S. total value of shipments from 1971 to 1973.
(5) BTUs are regionally prorated using for each year the ratio of employment in a state to total U.S. employment multiplied by total U.S. BTUs.

EXHIBIT XI-3
FEO:USDC
SIC 3069[1] - VALUE OF SHIPMENTS--1967, 1971-1974
(Millions of Dollars)

Line	Item	1967	1971	1972	1973	1974[7] Low	1974[7] High
1.	Value of products and services sold by SIC 3069 industry[2]	$2,962.2	$3,552.0	$3,819.9	$4,250.0	$4,887	$5,160
2.	Value of SIC 3069 products shipped by SIC 3069 industry[3]	2,472.8	2,851.1	3,049.8	3,393.2	3,902	4,120
3.	Value of SIC 3069 products shipped by all industries[4]	2,762.4	3,174.6	3,385.4	3,766.6	4,331	4,573
4.	Ratio of value of SIC 3069 products shipped by SIC 3069 industry to value of SIC 3069 products shipped by all industries (coverage ratio)[5]	0.90	0.90	0.90	0.90	0.90	0.90
5.	Value of major SIC 3069 product categories shipped by SIC 3069 industry:[6]						
	Rubber and plastics belts and belting	$ 223.5	$ 296.9	$ 320.6	$ 367.3	$ 422	$ 458
	Rubber hose and tubing	399.1	429.1	525.5	592.5	681	729
	Sponge and foam rubber goods	232.6	253.4	280.6	310.4	357	374
	Rubber floor and wall covering	56.8	72.5	79.0	90.1	104	112
	Mechanical rubber goods, n.e.c.	893.9	1,056.5	1,049.1	1,154.8	1,328	1,388
	Rubber heels and soles	105.3	97.9	114.6	124.3	143	147
	Druggist and medical sundries	75.6	103.8	105.0	119.1	137	148
	Other rubber goods, n.e.c.	385.3	407.0	430.7	469.5	540	557
	Fabricated rubber products, n.e.c., n.s.k.	100.7	134.0	144.7	165.2	190	207
6.	Value of products and services sold by SIC 3069 industry in 1967 dollars[8]	$2,962.2	$3,010.2	$3,156.9	$3,373.0	$3,373	$3,559

Footnotes:

(1) SIC 3069 defined according to 1972 classification of this industry and for purposes of this study, includes figures for SIC 3041.

(2) Figures for 1967 obtained from value in line 3 using same ratios as established in Source (a) for the original classification of this industry. Figure for 1971 obtained from Source (b) modified by Snell estimate for "fabricated rubber product, n.e.c., n.s.k." and by Snell estimate of effect of reclassification of this industry based on data from Sources (a), (b), (c), (d), and (e). Figure for 1972 obtained from Sources (c) and (d) plus Snell estimate for "rubber and plastics hose and belting, n.s.k." based on data from Source (a). Figure for 1973 obtained from Source (e). Figures for 1974 obtained from values in line 2 using same ratio as for 1972.

(3) Figures for 1967, 1971, 1972 and 1974 represent sums of values for individual product categories in line 5. Figure for 1973 obtained from value in line 1 using same ratio as for 1972.

(4) Figures for 1967 and 1972 obtained from Sources (c) and (d) plus Snell estimates for "other rubber and plastics hose, n.e.c., n.s.k." and "rubber and plastics hose and belting, n.s.k." based on data from Source (a). Figure for 1971 obtained from Source (b) modified by Snell estimate for "fabricated rubber products, n.e.c., n.s.k." and by Snell estimate of effect of reclassification of this industry based on data from Sources (a), (b), (c), (d), and (e). Figures for 1973 and 1974 obtained from value in line 2 using ratio in line 4.

(5) Ratios for 1967, 1971 and 1972 calculated by dividing values in line 2 by values in line 3. Ratio for 1972-1974 assumed to be constant.

(6) Figures for 1967 and 1971 obtained from Sources (a) and (b) using the 1967 coverage ratio for each product category. In the case of "rubber hose and tubing," "mechanical rubber goods, n.e.c.," and "other rubber goods, n.e.c.", the figures have been modified to reflect the 1972 census classification. The value of 1971 "fabricated rubber products, n.e.c., n.s.k." is a Snell estimate based on data from Sources (a), (b), and (c). Figures for 1972 obtained from Sources (c) and (d). Figures for 1973 reflect weighted growth rates based on historical patterns from 1967 to 1972.

(7) Figures for 1974 built up from individual product category figures which are estimated to range from a minimum of zero growth to a maximum of a continuation of the historical growth rate from 1967 to 1973. All figures reflect a price increase of 15%.

(8) Figures calculated from values in line 1 using the following price index: 1967 - 100; 1971 - 118; 1972 - 121; 1973 - 126; 1974 - 145 (date on index for 1967, 1971, and 1972 obtained from Source (g).

Sources:

(a) "Industry Statistics," 1967 Census of Manufactures, U.S. Department of Commerce, Vol. II, Part 2, Major Groups 25-33, pp. 30A1-33.

(b) "Value of Product Shipments," Annual Survey of Manufactures - 1971, U.S. Department of Commerce, Publication M71(AS)-2, October 1973.

(c) "Fabricated Rubber Products, N.E.C., SIC 3069," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC72(P)-30A-5, March 1974.

(d) "Rubber and Plastics Hose and Belting, SIC 3041," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC72(P)-30A-4, February 1974.

(e) "General Statistics for Industry Groups and Industries," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC72(A)-1.

(f) "Rubber and Plastics Products Projections 1973-80," U.S. Industrial Outlook 1974, U.S. Department of Commerce, 1973, p. 114.

(g) "Wholesale Price Indexes By Commodities, 1950 to 1972 (Miscellaneous Rubber Products)," Statistical Abstract of the United States 1973, U.S. Department of Commerce, July 1973.

EXHIBIT XI-4
FEO: USDC
SIC 3069 - ENERGY FACTORS 1967, 1971, AND 1973
(Per Million 1967 Dollars Produced)

Line	Item	Units	Year 1967[1]	1971[1]	1973[2]
1	Value of shipments not reflecting 1972 Census Redefinition of the Industry[1]	Million (1967) dollars	3,139	2,962	(X)
2	BTUs equivalent of fuels	Billion BTUs	10.34	13.67	15.3
3	Coal	1,000 short tons	0.166	0.110	0.08
4	Distillates	1,000 barrels	0.126	0.230	0.28
5	Residual	1,000 barrels	0.361	0.420	0.45
6	Natural gas	Billion cu. ft.	0.0029	0.0066	0.0085
7	Other fuels				
8	Fuels nsk.				
9	Electricity purchased	Million KWH	0.713	0.911	1.01
10	BTUs equivalent of purchased electricity	Billion BTUs	7.56	9.66	10.7
11	Electricity generated		0.020	(NA)	
12	BTUs equivalent of fuels and purchased electricity	Billion BTUs	17.90	23.33	26.0

(1) Census data from "Fuels and Electric Energy Consumed," MC67(S)-4 and MC72(SR)-6 divided by Line 1, derived from data in Exhibit XI-3.
(2) Straight line extrapolation of 1967 to 1971 trends.

SECTION XII

SIC 3079 MISCELLANEOUS PLASTICS PRODUCTS

The 1972 census definition was used for SIC 3079 since in the study of SIC 2821, Plastics Materials, output data by all sources corresponded significantly more closely to the 1972 census definition and data than to the 1967 census definition. Further, correlation with major product data is more meaningful in SIC 2821 by the 1972 census definition. Items removed in the 1972 census definition from SIC 2821 were essentially completely transferred to SIC 3079 and thus redefinitions of these two sectors in the 1972 census are accounted for in this study, although an opportunity for refinements exists as the census bridge tables become available. Using the 1972 census definition in the study of SIC 3079 therefore presents a realistic statement of the energy and other profiles of the plastics processing industry. Exhibit XII-1, at the end of this section, presents a detailed industry definition.

The most important findings follow regarding the economic impact of the petroleum based materials shortages during 1973 and the first quarter of 1974:

- Fuel shortages have been of concern, but have not been the cause of serious disruptions.
- Material shortages have been a major problem to the industry resulting in significant cutbacks in production.
- Employment was noticeably affected along with the overall impact on the industry.
- No major near-term opportunities for substitution and/or conservation of fuels were identified.
- The major industry processing techniques are similar in terms of energy efficiency.

Exhibit XII-2, following Exhibit XII-1, features the Required Tables. These tables and supporting exhibits further define the industry's structure both in economic and energy terms.

All exhibits appear sequentially at the end of this section. Whenever electricity KWHs are expressed as BTUs, conversion is based on the nominal fuel requirements to generate the electricity.

1. MAJOR USES OF FUELS, ENERGY, AND PETROLEUM PRODUCTS

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

1.1 Task I, Major Processes

Extrusion, injection, and blow molding are the three major manufacturing processes used by the industry. They account for the vast majority of products produced by the manufacturers.

1.1.1 Extrusion

Extruders accept powder or pellets from a feed source, subject the material to heat and compression (working) by a helically flighted rotating screw for complete melting and mixing, then pump the melt continuously through the extruder die which establishes the basic shape of the extruded material, such as sheet, rod, pipe, specialized profilm, etc. In certain applications, the extruded products are the end-products desired. On others, additional work is performed, such as thermoforming, heat sealing, fibrillating, bending and cutting before reaching the final product. Extruders are also widely used to coat wire and cable, paper, foil or cloth.

The power requirements for extruders vary from 0.1 KWH to 0.5 KWH per pound processes, based on analysis of available engineering data and interviews with equipment manufacturers. However, the total energy required in the production of the final article is greater than this where further processing is required as noted above, or where product yield is substantially less than 100%. These yields can be as low as 60%, and raw material costs are usually minimized by recycling scrap.

1.1.2 Extrusion Blow Molding

Blow molding is a sophisticated process that makes use of many types of equipment to produce containers ranging is size from fractional oz. to 55 gal. and greater, as well as industrial and consumer parts having no relation to containers. Any thermoplastic can be blow molded with varying degrees of success.

In point of commercial volume, far more containers are produced by blow molding than any other type process, and more high-density polyethylene is used in blow molding than all other resins combined.

Regardless of the type of blow molding process used, three steps are basic to all:

1. Formation of a hollow tube of molten resin called a parison;

2. Positioning of the parison between mold halves;

3. Blowing of the parison so that it takes the shape of the mold.

Extrusion blow molding requires from 0.25 to 0.3 KWH per pound processed

1.1.2 Injection Molding

Injection molding is similar to extrusion in the development of a polymer melt. In the case of injection molding, however, the extrusion part of the process is intermittent. The polymer melt is accumulated in a cavity either at the head of the screw or completely separate from it, from which it is injected into a cold mold which has the dimensions of the article desired (plus factors for shrinkage). Many different combinations of molds and plasticizing equipment are available depending upon the article to be made and the material it is to be made of. In recent years, injection molding has begun to be applied to thermosets as well as thermoplastic materials.

Energy requirements for injection molding are in the same range as for extrusion blow molding.

It is to be noted that electrical energy requirements, estimated at 0.74 KWH per pound processed for the entire industry in 1973, while on the high side, are not inconsistent with the single process data. However, the fuels requirements of 4000 BTUs per pound (equivalent to 3 lbs of steam) appear quite excessive, since many of the principal processes do not even require use of electrical resistance heating, relying mostly on

adiabatic heating. A possible reason for the high fuel consumption may be for in-house polymerization. The amount involved for the industry could be of the order of about 20% of total production for the years under study and might account for as much as 70% of total fuel usage.

1.2 Task II, Industry Output

Exhibit XII-3 summarizes estimates of the value of overall industry shipments as well as the value of shipments by major product and product group for 1967 and 1971-1974. In 1973, the value of all products and services sold by SIC 3079 industry was about $13 billion.

Exhibits XII-4 and 5 summarize production volume in, respectively, the same terms and in terms of the major processing techniques. In 1973, total production of SIC 3079 products by SIC 3079 industry was about 13 billion pounds. Total production of SIC 3079 industry was about 15 million equivalent pounds.

Based on the data in Exhibits XII-3 and 4, Exhibit XII-2-1 provides the information of Required Table 1.

1.3 Task III, Energy Related Profile of Major Processes

Energy factors have been estimated for the three major plastics processing techniques and have been presented in Task I above. However, as these factors vary widely within each particular process depending upon a number of variables, e.g., size and type of machine used, material processed, and article produced, Required Tables 2, 3 and 4 have not been constructed.

It is estimated that the three major processes account for 80% of all plastics materials consumed. Because of their relatively low energy consumption, they probably account for a smaller portion of the fuels and energy consumed.

1.4 Task IV, Shifts In The Energy Related Profile Of The Industry - 1971 to 1973

Exhibit XII-6 summarizes industry level energy factors based on census data and Snell estimates. The factors for 1967 and 1971 were developed from census data concerning the consumption of fuels and energy in these years and industry production based on the 1967 census definition of the industry. The factors for 1973 were obtained by straight-line extrapolation of the 1967 and 1971 data based on the assumption of essentially constant process mix as illustrated in Exhibit XII-5. Using this data, and the estimated production volume for the industry according to the 1972 census definition as shown in Exhibit XII-4, Exhibit XII-2-5 was prepared, presenting Required Table 5.

The following are observations from Exhibit XII-6 regarding fuel shifts from 1971 to 1973 in terms of fuel requirements per equivalent unit of production:

- A shift away from the use of coal (65% reduction per equivalent pound of resin produced).
- A shift away from the use of distillates (7% reduction per pound).
- A shift away from the use of residual fuel oil (96% reduction per pound).
- Purchased electricity also showed a decrease in consumption per pound of production this being about 27% between 1971 and 1973.
- Fuel energy and total energy consumption for SIC 3079 industry decreased 13% and 23%, respectively, from 1971 to 1973 on a per pound basis.

The following are observations from Exhibit XII-2-5 regarding shifts in the energy profile of SIC 3079 from 1971 to 1973:

- The total BTU requirements of the industry increased about 8%.

- The following energy items increased at a rate above the industry level increase:

  - distillates: 31%
  - natural gas: 41%

- The following energy items increased at a rate below the industry level increase or decrease:

  - residuals: 95% decrease
  - coal: 50% decrease
  - electricity: 2% increase

An outstanding feature of the evolution of the energy utilization factors in SIC 3079 is the considerable reduction of the overall energy required per unit production. Taking into account the limitation of validity of the parameter chosen as indices of production activity, the reduction by more than 30% of the requirements represents nevertheless, a "real life" phenomenon. It can be best explained by considering a typical example, that of two lines of injection molding. An older line with a capacity of 452 pounds per hour used 0.224 KWH per pound produced. A newer line with a capacity of 1086 pounds per hour uses 0.126 KWH per pound produced. The energy trend would then reflect a general change toward more efficient technology.

The figures support the generally observed trend of increasing reliance on natural gas for small and moderate scale heat energy producing units. The 1973 estimates of fuel oil consumption might, however, still be on the low side. It could be that linear extrapolation of the 1967 and 1971 energy factors was not valid for this fuel. A more in-depth analysis is required to determine whether or not this is the case.

1.5 Task V, Projected 1974 Energy Related Profile of the Industry

Exhibit XII-2-5 also presents the projected energy profile of SIC 3079 for 1974. The profile was developed assuming the same energy factors for 1974 as for 1973, shown in Exhibit XII-6. The factor was applied to the average expected production of 1974, i.e., the average of the "low" and "high" figures given in line 2 of Exhibit XII-4. Use of the 1973 energy factor assumes no significant reduction in the energy required per unit of production from 1973 to 1974, and a total energy requirement of 190,000 billion BTUs is projected for 1974.

2. GEOGRAPHIC PATTERN OF USE

The principal outputs from the tasks of this subsection are Required Tables and analysis of findings.

2.1 Task I, Geographic Pattern of the Industry's Energy Related Profile - 1971 to 1973

The SIC 3079 industry is so widespread among a large number of establishments it is difficult to define a specific concentration pattern. It might, however, be said that this industry is concentrated in the industrial states. The Required Tables in Exhibits XII-2-6, 7, and 8 define the geographic distribution of this industry's energy related profile.

2.2 Task II, Geographic Pattern of Employment and Shipments

Employment and origin of shipments appear to be concentrated in the major industrial states. Snell estimates of the employment pattern were used as the basis for distributing industry level shipments among the states. Exhibit XII-2-8 presents the Required Table on employment and shipments. The major SIC 3079 industry states according to these two means of measurement are Ohio, California, New York and Illinois, each of which had 1973 values of shipments in excess of $1 billion.

2.3 Task III, Shifts in the Patterns

The only states with appreciable shifts in the value of shipments, employment, and fuels and energy consumption between 1971 and 1973 were New Jersey (negative), Florida (positive), and California (positive). Other states also showed some significant changes, but they were either smaller percentagewise or less important in absolute numbers. At the industry level, 1971 to 1973 shifts were as follows:

- There was about a 42% increase in the value of products and services sold by SIC 3079 industry (Exhibit XII-3).
- There was a 22% increase in employment.
- There was about an 8% increase in the amount of fuel and energy consumed.

3. FUEL AND ENERGY SUPPLY SITUATION

The principal output from the tasks of this subsection is analysis of findings.

3.1 Task I, "Normal" Stocks of Materials

Data collected through Snell's telephone survey of chief executives of the plastics products industry indicates that stocks of fuel oils in SIC 3079 industry in recent years have amounted to 30-180 days production requirements. In this industry, natural gas and electricity are the principal sources of energy.

As most of the information collected with regard to stocks of fuels and raw materials was of a qualitative nature, Required Table 9 is not presented for SIC 3079.

3.2 Task II, Shifts in Stocks

During 1973 and the first quarter of 1974, SIC 3079 stocks of resin materials have been greatly reduced. In a number of cases, these stocks amounted to only a few days production requirements. In other cases, the level of stocks represented recent purchases of scarce materials in an effort to prepare for periods when there is no availability of these materials. See Exhibit XII-7,8,9 and 10 for further details.

3.3 Task III, Captive Use

Many firms classified in SIC 3079 are relatively small operations, independent of oil companies or petrochemical firms. For these establishments there is essentially no captive production of fuels or resins. Other, often large companies are affiliated with oil companies or petrochemical firms and have a greater assurance of fuel and plastics materials supplies. Required Table 10 is not presented due to lack of sufficient quantification.

3.4 Task IV, Sources of Supply

Fuel and electricity for SIC 3079 plants are typically purchased from outside the industry. Natural gas and electricity are supplied by utilities. Required Table 11 is not presented for SIC 3079.

3.5 Task V, Proportion by Type of Supplier

It is common for one type of supplier to supply the fuel and energy needs of plastics products manufacturers throughout the industry. These firms have been briefly described in Task IV above.

3.6 Task VI, Seasonality of Use

Taken as a whole, SIC 3079 industry operates at near full capacity year round. Certain segments of the industry do, however, show some seasonality, e.g.:

- The toy segment is its busiest during the summer and fall in order to meet the demands of the Christmas season.
- Those firms making school supplies are busiest during the spring and summer.
- Businesses manufacturing PVC pipe produce at full capacity during the winter months in preparation for the summer construction season.

Required Table 12, which is designed to state this information quantitatively, is not presented for SIC 3079 because of the lack of specific figures for the industry.

4. SUBSTITUTABILITY AND CONSERVATION OF MAJOR FUELS AND PETROLEUM PRODUCTS

The findings in this section were developed through industry interviews, review of secondary sources and review of in-house information.

4.1 Task I, Major Processes

The three major processes used in the production of plastics products require electrical energy to power the motors and heaters in the equipment used throughout the industry. Any saving in the use of petroleum based fuels used in the generation of this electrical power, or for the generation of working space heat, would therefore have to be traced back to the utilities which supply this energy.

In many applications, one resin can be substituted for another. This may assist plastics processors in overcoming temporary shortages of raw materials, but will not help in alleviating the dependence of the industry on petroleum based products. Substitutions of conventional materials (paper, metals, etc.) can also be made for products presently made from plastics. Such substitutions would, however, in most cases not be made by firms classified in SIC 3079.

4.2 Task II, Quantification of the Major Substitutability and Conservation Opportunities

As indicated in Task I above, major opportunities for the substitution for and or conservation of petroleum based materials do not exist. Any voluntary savings must therefore be confined to conservation of such materials through use of lower plant temperatures, less lighting and other such operating practices

4.3 Task III, Principal Constraints

The principal constraint on the plastics products industry in 1973 and the first quarter of 1974 has been a shortage of the resins from which these products are manufactured. Most plastics processors are reported to be able to sell what they can produce, but are able to get only a certain percentage of their former resin supplies on an allocation basis.

- There have been shortages of certain formulations where intermediate chemicals are not available (e.g. styrene monomer for polyester resin is in extremely tight supply).

- Some resin producers have been unable to supply new markets with resin.

- Some traditional resin consumers have been unable to obtain increased supplies of standard resin formulations.

The Phase IV price controls are claimed to have caused some problem on any product or material where freight costs have been included in the frozen price. In such cases, customers at distant locations from producing points have found themselves at a disadvantage. In addition, the lack of any controls regarding export prices, has caused resin producers to look outside the United States for more lucrative markets. The easing of Phase IV price controls were designed to help to alleviate this situation.

4.4 Task IV, Plant Level Operating Characteristics

The production of plastics products is primarily dependent upon supply of raw materials and on electricity and fuels to power the machinery. Any cutbacks in either of these areas will result in an essentially proportional reduction in the output of SIC 3079 products (this assumes a reduction in the supply of electricity on an allocation basis rather than on a cutback in voltage which cannot be tolerated). As most plastics processing firms have a number of production machines and operate on a multi-shift basis, such reductions in output can be accomplished through a decrease in the utilization of capital equipment either selectively or on a per-shift basis.

Interview respondents indicated that typical breakeven points of SIC 3079 manufacturers fall in the 65-85% of capacity range. Although a reduction in the utilization of capital equipment will most likely have a detrimental effect on the profitability of these manufacturers, this effect will be minimal because of the large variable cost content in the production of plastics products.

4.5 Task V, Capital Stock (1973)

The 1973 gross book value of fixed assets was roughly \$5 billion according to the 1972 census redefinition of SIC 3079. The estimate is based on the following

- The 1971 Annual Survey of Manufactures indicates that the gross book value of fixed assets was \$3,711 according to the 1967 census definition. The 1972 census redefinition increased equivalent production by about 18%. Applying this factor, the gross book value was roughly \$4.4 billion in 1971 according to the redefinition.

- According to the 1972 census, MC72 (P)-3A-6, capital expenditure were \$682 million in 1972, accompanied by a 2.6 billion pounds increase in production from 1971 to 1972. Production in 1973 was estimated at 1.8 billion pounds above 1972. At the same proportion of capital expenditures and retirements as in previous years, these output increases from 1971 to 1973 would indicate capital expenditures of about \$1.2 billion and an increase in gross capital assets of about \$500 billion.

The average estimated 1973 capital cost is about \$.30 per pound of capacity. The 1973 production by SIC 3079 industry was about 15 billion equivalent pounds. Assuming this represented 85% of capacity utilization, the replacement value of present production capacity is about \$5.3 billion.

4.6 Task VI, Planned Capital Investment (1974)

According to Current Industrial Outlook 1974, the plastics processing industry was expected to grow about 9% in 1974 or about 1,400 million pounds. On the basis of historical data, this would have required a capital expenditure of around \$400 billion.

4.7 Task VII, Changes to Investment Plans

The recent crunch in resin supplies has led many plastics processors to change their plans for capital expenditures in 1974. A recent survey published in the March 18 issue of Plastics World states that 12% of the companies contacted have cancelled a machinery order, 44% have deferred placing an order, and 13% have pushed back delivery dates. With the possibility of a year of limited or no growth in production, capital expenditures could run in the range of \$250-300 million.

5. INTRA INDUSTRY EFFICIENCY

The findings in this section were developed through industry interviews, review of secondary sources, and review of in-house information.

5.1 Task I, Energy Efficiency

Snell estimates of energy factors for the three major plastics processing techniques show little difference between these processes in the amount of energy required per pound of material processed. Furthermore, as manufacturing facilities are made up of a number of machines, no significant variation in energy efficiency as a function of plant size is expected. In cases where SIC 3079 establishments have polymerization facilities, energy consumption is expected to be significantly higher, particularly in fuel use.

5.2 Task II, Major Factors Affecting Efficiency

The firms in the plastics products industry have taken steps to conserve energy where possible. These energy conservation measures have included:

- Decrease in office and plant lighting
- Lowering and locking of thermostats
- More efficient scheduling of deliveries by company owned vehicles
- Closing of plants on weekends

Conservation efforts are, however, not likely to be a major factor affecting energy efficiency in the long run. The steps mentioned above will help somewhat in the near term, but the maximum effect on energy efficiency is not expected to be more than a 5% improvement.

6. PRINCIPAL CONSTRAINTS ON CURRENT INDUSTRY OPERATIONS

The findings in this section were developed through industry interviews, review of secondary sources, and in-house information.

6.1 Task I, Important Constraints

Constraints on any industry's operations can be basically either supply or demand oriented. In the case of SIC 3079, the Plastics World survey reports there has been no reduction in the demand for the industry's products. On the supply side, however, serious problems have been encountered with the supply of the plastics resins required by the industry. With regard to fuel and energy supplies, no serious shortages have been reported.

6.2 Task II, Most Serious Constraint

The most serious constraint on industry production has been that of shortages in petroleum-based raw materials. The Plastics World survey indicates that 46% of the processors in the industry do not have enough resin to meet current production demands. An additional 42% presently have adequate supplies, but are concerned about the availability of future supplies. As reported in the survey, the resins in tightest supply are polystyrene, PVC, polyolefins, polyester, and engineering plastics.

6.3 Task III, Shortfalls in Supply and Price Increases

Before signs of the shortages in petroleum-based products appeared, estimates of industry growth were about 8-10%. The February 1974 industry interviews suggest that 1974 will be a year of, at the best, very limited growth. Increases in the prices of plastics products are expected to be at least 10% over those of 1973, these being mainly the result of increased raw material prices, but supported by a continued demand for SIC 3079 products.

There is evidence that the raw material shortages have caused serious declines in employment in the plastics products industry.

- Exhibit XII-7 presents the results of a survey regarding the "energy/resin emergency" by the Society of Plastics Industry (SPI), initiated during mid-December, 1973.
  - the survey predates the January 30, 1974 decontrol of petrochemicals and plastics resins by the Cost of Living Council
  - the survey appears to give coverage principally to large processors; the median employment level of respondents is 146.
- Exhibit XII-8 presents the results of a survey of processors by Plastics World.
  - the survey was initiated during mid-January 1974
  - coverage is of processors with over 1.5 million dollars of revenue
- Exhibit XII-9 presents the preliminary results of a survey of small processors by The Organization of Plastics Processors (TOPP).
  - the survey was initiated during December 1973, as part of the membership application for the newly formed TOPP
  - coverage is of small to medium sized processors, and the survey results are slanted by self-selection toward those processors experiencing shortages
  - the average company size is provisionally estimated by TOPP to be 55 employees

- Exhibit XII-10 presents the results of a late-February 1974 limited survey by Snell of processors in the size ranges roughly covered by the SPI and Plastics World surveys.

- Many processors in these surveys are probably not classified by census under SIC 3079 because their primary product manufacture falls under other SICs. It is assumed that trends among all plastics processors are indicative of trends among those processors in SIC 3079.

Based on the available survey data, the end of 1973 and early 1974 decline in employment in the plastics products industry is estimated at 20,000 to 35,000 layoffs.

- The SPI and Plastics World survey cover primarily large processors. Exhibit XII-11 presents a distribution of employment in the SIC 3079 by size of establishment.

  - large processors in SIC 3079 are defined to have 100 or more employees

  - large processors in SIC 3079 probably account for roughly 50% of total employment, corresponding to about 150,000 employees in 1972

  - The SPI and Plastics World surveys indicate a 5% to 10% recent decline in employment due to the shortages, corresponding to 7,500 to 15,000 layoffs.

- The TOPP survey covers primarily medium and small processors with less than 100 employees

  - medium and small processors represent roughly 50% of total employment, corresponding to about 150,000 employees in 1972

  - since the 25-30% employment declines reported by the TOPP survey are based on self-selection by applicants experiencing difficulties, these decline estimates are probably overly pessimistic for all medium and small processors in SIC 3079

- Snell's judgment is that these declines are more likely 10 to 15% corresponding to estimated declines among medium and small processors of 15,000 to 20,000

- The estimated total employment declines for SIC 3079 are 20,000 to 35,000 layoffs.

6.4 Task IV, Outputs Critical to Subsequent Production

Many of the outputs of SIC 3079 industry are critical to subsequent production.

- Some of these include:

  - packaging
  - construction
  - automobile
  - appliances

Snell interviews indicate great concern as to the cascading effect of a decline in the plastics products industry or other industries. Quantification of this effect is, however, not possible without a specific, in-depth study in this area.

EXHIBIT XII -1 (1)
FEO: USDC
DEFINITION OF SIC 3079

SIC 3079 MISCELLANEOUS PLASTICS PRODUCTS

Establishments primarily engaged in molding primary plastics for the trade, and fabricating miscellaneous finished plastics products. Establishments primarily engaged in manufacturing fabricated plastics products or plastics film, sheet, rod, nontextile monofilaments and regenerated cellulose products, and vulcanized fiber are classified in this industry, whether from purchased resins or from resins produced in the same plant. Establishments primarily engaged in compounding purchased resins are also classified in this industry. Establishments primarily engaged in manufacturing artificial leather are classified in Industry 2295.

Air mattresses, plastics
Aquarium accessories, plastics
Awnings, fiber glass and plastics combination
Bands, cellulose
Bands, viscose
Battery cases, plastics or plastics composition
Bearings, plastics
Billfold inserts, plastics
Blister and bubble formed packaging, plastics
Boats, nonrigid: plastics
Bottles, plastics
Bowl covers, plastics
Boxes, plastics
Brush handles, plastics
Buckets, plastics
Caps, cellulose
Carafes, plastics
Casein products, molded for the trade
Cases, plastics
Casting of plastics, for the trade
Cellophane
Celluloid products, molded for the trade
Closures, plastics
Clothes hangers, plastics
Clothespins, plastics
Composition stone, plastics
Containers, plastics: except bags
Cups, plastics, including foamed
Custom compounding of purchased resins
Dishes, plastics
Doors, folding: plastics or plastics coated fabric - metal frame
Downspouts, plastics
Drums, plastics (containers)
Engraving of plastics
Fiber, vulcanized: sheets, rods, tubes, etc.
Film base, cellulose acetate or nitrocellulose plastics (nonsensitized)
Floor and wall covering, unsupported plastics
Flower pots, plastics
Foamed pads and packaging, plastics
Foams, plastics
Gloves and mittens: plastics
Gutters, fiberglass
Gutters, plastic: glass fiber reinforced
Hardware, plastics
Heels, boot and shoe: plastics
Ice chests or coolers, portable: foam plastics
Identification cards, plastics
Injection molding of plastics, for the trade
Insulation and cushioning material, foamed plastics
Kitchenware, plastics
Kits, plastics
Laminated plastics sheets, rods, and tubes
Laminating of plastics, for the trade
Lamp bases, plastics
Laundry tubs, plastics: glass fiber base
Lenses, plastics: except ophthalmic or optical

EXHIBIT XII-2-1
FEO:USDC
REQUIRED TABLE 1

Proportion of Industry Output Accounted for by Each Major Process, 1973

SIC 3079 Industry Miscellaneous Plastics Products

Process and Major Products	Percent of 1973	
	Shipments Value	Production Volume 1/
Unsupported plastics film, sheets, sheeting, rods, tubes and other stock shapes	12.6%	21.1%
Foamed plastic products	6.8	7.3
Laminated sheets, rods and tubes	4.9	1.9
Plastics packaging and shipping containers	10.9	11.7
Industrial plastics products	14.8	10.4
Construction plastics products	11.0	14.3
Plastics dinnerware, tableware, and kitchenware	3.6	2.5
Regenerated cellulosic products (except rayon)	3.5	5.8
Custom compounded purchased resins	1.2	2.3
Consumer and commercial plastics products, n.e.c and miscellaneous plastics products, n.s.k	18.5	10.6
Secondary products and miscellaneous receipts	12.2	12.1
Total Industry (Percent)	100.0	100.0
(Actual)	$12,985,000,000	14,973,000,000

1/ Production volume expressed in pounds.

Source: Exhibits XII-4 and XII-5.

EXHIBIT XII - 2-5
FEO: USDC
REQUIRED TABLE 5

Industry Consumption of Fuels, Petroleum Products, and Energy by Type - 1971, 1973, and 1974

SIC 3079 Industry Miscellaneous Plastics Products

Line No.	Type of Energy or Material	Unit of Measure	Volume (1) 1971	Volume (1) 1973	Volume (1) 1974	Bil. BTU s 1971	Bil. BTU s 1973	Bil. BTU s 1974	% Change 1971-73	% Change 1973-74	% of Total BTU s 1971	% of Total BTU s 1974
1	Propane, butane, and mixtures											
2	Middle distillates	1,000 barrels	1,032	1,350	1,470	6,030	7,900	8,600	31	8.9	3.8	4.3
3	Residual fuel oil	1,000 barrels	595	30	30	3,770	200	200	(95)	-	2.4	0.1
4	Chemical feedstocks											
5	Other petroleum, products, total											
6	Petroleum products, total											
7	Coal	1,000 short tons	90.5	45	49	2,400	1,200	1,300	(50)	8.3	1.5	0.7
8	Natural gas	billion cu. ft.	31.9	45	49	32,900	46,400	51,600	41	11.2	20.5	27.0
9	Fuels, n.e.c. total											
10	Other fuels, total											
11	Electrical energy (purchased only)	billion KWH	19,853	11,100	12,100	115,600	117,700	128,300	2.3	9.0	71.8	67.9
12	GRAND TOTAL		(X)	(X)	(X)	160,100	173,400	190,000	8.3	9.6	100%	100%

Source:

(1) The energy factors of Exhibit XII-6 multiplied by production figures for the industry (as redefined by the 1972 census) from line 1 of Exhibit XII-4. For 1974 the 1973 energy factors were applied to the average of the "High" and "Low" production in 1974.

EXHIBIT XII-2-6 a
FEO:USDC
REQUIRED TABLE 6

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit

SIC 3079 Industry Miscellaneous Plastics Products Year 1971

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
1	United States		1,032	5,958			9,800	90.5	31.9		35,300	115,000	160,100
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.		8.6	50			80	0.8	0.3		300	970	1,350
6	Vermont												
7	Mass.		55	317			500	4.8	1.7		1,890	6,170	8,580
8	R.I.												
9	Conn.		18	104			170	1.6	0.6		620	2,030	2,820
10	Middle Atlantic		217	1,254			2,030	1.9	6.6		7,460	24,400	33,900
11	N.Y.		80	460			750	7.0	2.5		2,740	8,960	12,440
12	N.J.		76	442			720	6.7	2.4		2,630	8,600	11,930
13	Penn.		61	352			570	5.3	1.7		2,090	6,850	9,520
14	NORTH CENTRAL												
15	E. North Central		335	1,936			3,140	29.3	8.5		10,130	37,670	52,330
16	Ohio		125	723			1,180	10.9	1.9		4,300	14,100	19,550
17	Ind.		45	258			420	3.9	1.4		150	5,000	6,970
18	Ill.		88	508			820	7.7	2.8		3,020	9,900	13,700
19	Mich.		58	335			540	5.1	1.8		1,990	6,500	9,050
20	Wisc.		19	112			180	1.7	0.6		670	2,180	3,030
21	W. North Central												
22	Minn.		20	117			190	1.8	0.6		700	2,280	3,170
23	Iowa		11	61			100	0.9	0.3		360	1,190	1,650
24	Mis.		20	117			190	1.8	0.6		690	2,270	3,150
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

		Petroleum Products						Other Fuels					
Line Number	Geographic Unit	Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.												
33	D.C.												
34	Va.		16	92			150	1.4	0.5		550	180	2,490
35	W. Va.												
36	N.C.		19	108			170	1.6	0.6		640	2,090	2,910
37	S. C.		16	94			150	1.4	0.5		560	1,830	2,540
38	Ga.		14	80			130	1.2	0.4		470	1,550	2,150
39	Fla.		15	87			140	1.3	0.5		520	1,700	2,360
40	S.Central												
41	Ky												
42	Tenn.												
43	Ala.												
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas		39	227			370	3.4	1.2		1,350	4,410	6,120
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels n.e.c. (Bil. BTU s)*	Total (Bil. BTU's)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU's)*
59.	Pacific												
60	Wash.												
61	Ore.												
62	Cal.		99	570			925	8.6	3.1		3,392	11,101	15,420
63	Alas.												
64	Haw.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

(1) Based on the geographic distribution of BTU's from Exhibit XII - 2-8 and assuming the national distribution of fuels from Exhibit XII - 2-5.
(2) States for which SIC 3079 is not applicable or for which data is not available are found in Exhibit XII-2-8.

Consumption of Fuels, Petroleum Products, and Energy by Type, by Geographic Unit

SIC 3079 Industry Miscellaneous Plastics Products Year 1973

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU's)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU's)*	Total (Bil. BTU's)*	Purchased Electrical Energy (Bil. BTU's)*	Grand Total (Bil. BTU's)*
1	United States		1,350	30			8,100	45	45		47,600	117,700	173,400
2	NORTH EAST												
3	New England												
4	Maine												
5	N.H.		9.5	0.2			60	0.4	0.4		350	840	1,240
6	Vermont												
7	Mass.		6.7	1.7			410	2.6	2.6		2,450	5,940	8,740
8	R.I.												
9	Conn.		23	0.6			140	0.88	0.88		830	2,010	2,960
10	Middle Atlantic		227	5.8			1,380	8.8	8.8		6,830	19,990	29,400
11	N.Y.		109	2.8			660	4.2	4.2		3,950	9,590	14,100
12	N.J.		43	1.1			260	1.7	1.7		170	3,800	5,600
13	Penn.		75	1.9			460	2.9	2.9		2,710	6,590	9,690
14	NORTH CENTRAL												
15	E. North Central		425	11.1			2,690	16.5	16.5		15,460	87,550	55,200
16	Ohio		158	4.1			960	6.1	6.1		5,730	13,920	20,470
17	Ind.		62	1.6			380	2.4	2.4		2,270	5,510	8,100
18	Ill.		183	2.7			630	4.0	4.0		3,750	9,100	13,380
19	Mich.		79	2.1			480	3.1	3.1		2,870	6,980	10,260
20	Wisc.		23	0.6			140	0.9	0.9		840	2,040	3,000
21	W. North Central												
22	Minn.		27	0.7			160	1.0	1.0		970	2,350	3,460
23	Iowa		14	0.4			90	0.6	0.6		520	1,270	1,870
24	Mis.		24	0.6			145	0.9	0.9		860	2,090	3,080
25	N.D.												
26	S.D.												
27	Neb.												
28	Kansas												

* BTU's & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

EXHIBIT XII-2-7 b

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels, n.e.c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
29	SOUTH												
30	S. Atlantic												
31	Del.												
32	Md.												
33	D.C.												
34	Va.		16	0.4			100	0.6	0.6		590	1,440	2,120
35	W. Va.												
36	N.C.		25	0.7			150	1.0	1.0		910	2,210	3,250
37	S. C.		23	0.6			140	0.9	0.9		820	1,980	2,920
38	Ga.		19	0.5			120	0.8	0.8		700	1,700	2,500
39	Fla.		58	1.5			360	2.3	2.3		2,120	5,150	7,510
40	S.Central												
41	Ky												
42	Tenn.												
43	Ala.												
44	Miss.												
45	Ark.												
46	La.												
47	Okla.												
48	Texas		58	1.5			352	2.3	2.3		2,098	5,095	7,490
49	WEST												
50	Mountain												
51	Mont.												
52	Idaho												
53	Wyo.												
54	Colo.												
55	N.M.												
56	Ariz.												
57	Utah												
58	Nev.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Petroleum Products: Propane, Butane, & Mixtures (Thousand Barrels)	Distillates (Thousand Barrels)	Residual (Thousand Barrels)	Feedstocks (Thousand Barrels)	Other (Thousand Barrels)	Total (Bil. BTU s)*	Other Fuels: Coal (Thousand Short Tons)	Natural Gas (Bil. Cu. Ft.)*	Fuels n. e. c. (Bil. BTU s)*	Total (Bil. BTU s)*	Purchased Electrical Energy (Bil. BTU s)*	Grand Total (Bil. BTU s)*
59.	Pacific												
60	Wash.												
61	Ore.												
62	Cal.		140	3.6			850	5.4	5.4		5,080	12,340	18,150
63	Alas.												
64	Haw.												

* BTU s & Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

(1) Based on the geographic distribution of BTU s from Exhibit XII - 2-8 and assuming the national distribution of fuels from Exhibit XII - 2-5.
(2) States for which SIC 3079 is not applicable or for which data is not available are shown in Exhibit XII-2-8.

EXHIBIT XII-2-8a
FEO:USDC
REQUIRED TABLE 8

Shipments, Employment, and Fuels and Energy Consumed by Geographic Unit, 1971 and 1973

SIC 3079 Industry Plastics Fabrication

Line Number	Geographic Unit	Value of Shipments ($ Millions) 1971 (1)	1973 (4)	% Change	Employment 1971 (2)	1973 (3)	% Change	Fuels and Energy (5) (Bil. BTU s)* 1971	1973	% Change
1	United States	9,145	12,985	42	308,360	376,200	22	160,100	173,400	8.3
2	NORTH EAST	(NA)								
3	New England	(NA)								
4	Maine	(NA)			1,990	2,155	8.4	(NA)		
5	N.H.	77.2	93.4	21	4,170	4,630	11	1,350	1,240	(8.3)
6	Vermont	(NA)								
7	Mass.	490	659	34	18,805	22,190	18	8,580	8,740	2
8	R.I.	(NA)								
9	Conn.	161	223	38	6,870	8,245	20	2,820	2,960	5
10	Middle Atlantic	1,937	2,217	14	71,765	76,855	7.1	33,900	29,400	(13)
11	N.Y.	711	1,064	50	27,315	34,415	26	12,440	14,100	13
12	N.J.	682	422	(38)	26,350	21,080	(20)	11,930	5,600	(53)
13	Penn.	544	731	34	18,100	21,360	18	9,520	9,690	2
14	NORTH CENTRAL	(NA)								
15	E. North Central	2,990	4,164	39	96,990	116,885	21	52,330	55,200	6
16	Ohio	1,117	1,544	38	33,275	39,930	20	19,550	20,470	5
17	Ind.	398	611	53	14,420	18,455	28	6,970	8,100	16
18	Ill.	785	1,009	29	26,615	30,605	15	13,740	13,380	(3)
19	Mich.	517	774	50	15,790	19,900	26	9,048	10,260	13
20	Wisc.	173	226	31	6,890	7,995	16	3,030	3,000	(1)
21	W. North Central	(NA)								
22	Minn.	181	261	44	4,490	5,525	23	3,170	3,460	(1)
23	Iowa	94.2	141	50	2,550	3,215	26	1,650	1,870	13
24	Mis.	180	232	29	7,965	9,160	15	3,150	3,080	(2)
25	N.D.									
26	S.D.									
27	Neb.	(NA)								
28	Kans.	(NA)			4,860	2,175	(40)	(NA)		

* BTU s and Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Value of Shipments ($ Millions) 1971 (1)	1973 (4)	% Change	Employment 1971 (2)	1973 (3)	% Change	Fuels and Energy (Bil. BTUs)* 1971	1973	% Change
29	SOUTH	(NA)								
30	S. Atlantic	(NA)								
31	Del.	(NA)								
32	Md.	(NA)			2,720	3,565	31	(NA)		
33	D.C.									
34	Va.	142	160	13	4,545	4,855	6.8	2,490	2,120	(15)
35	W. Va.	(NA)								
36	N.C.	166	245	48	6,975	8,715	25	2,910	3,250	12
37	S.C.	145	220	52	3,265	4,150	27	2,540	2,920	15
38	Ga.	123	189	54	3,480	4,455	28	2,150	2,500	16
39	Fla.	135	571	397	2,165	6,660	208	2,360	7,570	221
40	S. Central									
41	Ky.	(NA)			2,445	3,790	55	(NA)		
42	Tenn.	(NA)			5,435	7,390	36			
43	Ala.	(NA)			1,540	2,435	58			
44	Miss.	(NA)			2,330	2,750	18			
45	Ark.	(NA)			1,340	2,380	78			
46	La.	(NA)			410	(NA)				
47	Okla.	(NA)			1,780	2,170	22			
48	Texas	355	565	59	7,665	10,040	31	6,120	7,490	22
49	WEST	(NA)								
50	Mountain	(NA)								
51	Mont.	(NA)								
52	Idaho	(NA)								
53	Wyo.									
54	Colo.	(NA)								
55	N.M.	(NA)								
56	Ariz.	(NA)								
57	Utah	(NA)								
58	Nev.	(NA)								

* BTU s and Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Line Number	Geographic Unit	Value of Shipments ($ Millions)			Employment			Fuels and Energy (Bil. BTU s)*		
		1971 (1)	1973 (4)	% Change	1971 (2)	1973 (3)	% Change	1971	1973	% Change
59	Pacific	(NA)								
60	Wash.	(NA)			995	1,490	50	(NA)		
61	Ore.	(NA)			675	792	26	(NA)		
62	Cal.	881	1,369	55	29,590	38,170	29	15,420	18,153	18
63	Alas.									
64	Haw.	(NA)								

* BTU's and Cu. Ft. of Natural Gas have been expressed in Billions rather than Millions.

Source: (1) "Annual Survey of Manufactures," 1971; adjusted by factor of 1.18 to reflect the 1972 census redefinition of the industry.
(2) "County Business Patterns (CBP)," 1971; adjusted as in (1).
(3) The Bureau of Labor Statistics (BLS) reports 289,100 total employment in 1971, 320,400 in 1972 and 355,100 in 1973. The 1972 to 1973 percent change in the BLS total employment figures was applied to the total U.S. and geographic employment figures from CBP, 1972, to obtain the 1973 estimates. CBP provides more regional data than BLS; adjusted as in (1).
(4) Total U.S. value of shipments is from Line 1, Exhibit XII-3. The regional values were estimated using an employment related change factor. For each percent change in the U.S. total employment a 1.9% change occurred in the U.S. total value of shipments from 1971 to 1973.
(5) BTU s are regionally prorated using for each year the ratio of value of shipments in a state to total U.S. value of shipments multiplied by total U.S. BTU s.

EXHIBIT XII-3
FEO: USDC

SIC 3079 - VALUE OF SHIPMENTS - 1967, 1971-1974
(Millions of Dollars)

LINE	ITEM	1967	1971	1972	1973	1974 (6) Low	1974 (6) High
1.	Value of products and services sold by SIC 3079 industry (1)	$ 5,941.0	$ 9,144.8	$ 11,087.7	$ 12,985	$14,277	$16,330
2.	Value of SIC 3079 products shipped by SIC 3079 industry (2)	5,361.0	8,039.1	9,747.0	11,415	12,551	14,355
3.	Value of SIC 3079 products shipped by all industries (3)	6,351.9	9,023.5	10,940.6	12,813	14,088	16,113
4.	Ratio of value of SIC 3079 products shipped by SIC 3079 industry to value of SIC 3079 products shipped by all industries (coverage ratio) (4)	0.84	0.89	0.89	0.89	0.89	0.89
5.	Value of major SIC 3079 product groups shipped by SIC 3079 industry: (5)						
	Unsupported plastics film, sheets, sheeting, rods, tubes, and other stock shapes	$788.5	$1,227.3	$1,444.5	$1,638.1	$ 1,082	$ 2,036
	Foamed plastic products	437.5	703.1	802.0	887.0	976	1,096
	Laminated sheets, rods, and tubes	323.6	434.1	538.2	635.6	699	783
	Plastics packaging and shipping containers	717.6	1,054.1	1,247.5	1,419.7	1,562	1,749
	Industrial plastics products	1,130.6	1,460.6	1,708.2	1,926.8	2,120	2,317
	Construction plastics products	371.5	663.2	1,018.9	1,431.6	1,575	1,972
	Plastics dinnerware, tableware, and kitchenware	189.9	280.5	372.7	464.8	511	594
	Regenerated cellulosic products (except rayon)	275.9	290.6	372.2	450.4	495	537
	Custom compounded purchased resins	199.2	265.2	198.6	161.3	171	177
	Consumer and commercial plastics products, n.e.c. and miscellaneous plastics products, n.s.k.	926.2	1,660.4	2,044.1	2,400.0	2,640	3,094

Footnotes:

(1) Figures for 1967, 1971, and 1972 obtained from Sources (a), (b), and (c). Data for 1967 and 1971 modified to correspond to 1972 definition of SIC 3079 industry. Figures for 1973 and 1974 obtained from value in line 2 using same ratio as for 1972.

(2) Figures for 1967, 1971, and 1972 calculated from values in line 3 using ratios given in line 4. Figures for 1973 and 1974 are sums of figures in individual product categories.

(3) Figures for 1967, 1971, and 1972 obtained from Sources (a), (d), and (c). Figure for 1973 and 1974 obtained from values in line 2 using ratio given in line 4.

(4) Ratio for 1967 is that which was established under the previous classification system. Ratio for 1972 is that established in Source (c). Ratio for 1971-74 has been assumed to be constant.

(5) Figures for 1967 obtained from Source (a). Figures for 1971 and 1972 obtained from Source (e) modified to give totals found in Census of Manufactures data. Figures for 1973 based on an overall growth rate of approximately 17% from 1972 to 1973 (developed from fact that thermoplastic and thermosetting resin shipments for 1973 were up 13.7% over 1972 and that prices for these resins were up about 5% over the same period (Sources (c) and (d)).

(6) Figures for 1974 built up from individual product category figures which are estimated to range from a minimum of zero growth to a maximum of a continuation of the historical growth rate from 1967 to 1973. In all cases, a 10% increase in prices over 1973 is assumed.

Sources:

(a) "Industry Statistics" 1967 Census of Manufactures, U.S. Department of Commerce, Vol. II, Part 2, Major Groups 25-33, 1971, pp. 28B1-25.

(b) "General Statistics for Industry Groups and Industries," Annual Survey of Manufactures - 1971, U.S. Department of Commerce, Publication M71 (AS)-1, April 1973.

(c) "Miscellaneous Plastics Products, SIC 3079," 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC72(P) - 30A-6, January 1974.

(d) "Value of Product Shipments," Annual Survey of Manufactures - 1971, U.S. Department of Commerce, Publication M 71 (AS)-2, October 1973.

(e) "Shipments of Selected Plastics Products 1972," Current Industrial Reports, U.S. Department of Commerce, Series: MA-30D (72)-1, November 1973.

(f) "The Modern Plastics Barometer," Modern Plastics, Volume 51, No. 1, January 1974, p. 5.

(g) "We Produced Over 13 Million Tons of Resins in '73," Modern Plastics, Volume 51, No. 1, January 1974, pp. 36-47.

EXHIBIT XII-4
FEO: USDC
SIC 3079 - PRODUCTION VOLUME - 1967, 1971-1974
(Millions of Pounds)

LINE	ITEM	1967 [1]	1971 [2]	1972 [2]	1973 [3]	1974 [4] Low	1974 [4] High
1.	Total production of SIC 3079 industry [5]	5,145.7	10,641.2	13,169	14,973	14,899	17,737
2.	Production of SIC 3079 Products by SIC 3079 industry [6]	4,643.4	9,354.5	11,576	13,162	13,097	15,591
3.	Total production of SIC 3079 products by all industries [7]	5,501.6	10,500.0	12,994	14,774	14,701	17,501
4.	Ratio of production of SIC 3079 products by SIC 3079 industry to production of SIC 3079 products by all industries [8]	0.84	0.89	0.89	0.89	0.89	0.89
5.	Production of major SIC 3079 products by SIC 3079 industry:						
	Unsupported plastics film, sheets, sheeting, rods, tubes, and other stock shapes	(NA)	2,420.7	2,889.0	3,160.8	3,161	3,616
	Foamed plastic products	(NA)	814.7	976.9	1,087.9	1,088	1,258
	Laminated sheets, rods and tubes	(NA)	227.2	262.5	289.9	290	328
	Plastics packaging and shipping containers	(NA)	1,298.2	1,567.2	1,755.3	1,755	2,040
	Industrial plastics products	(NA)	1,050.0	1,347.2	1,552.7	1,553	1,890
	Construction plastics products	(NA)	985.4	1,632.9	2,145.5	2,146	2,785
	Plastics dinnerware, tableware, and kitchenware	(NA)	266.6	327.2	371.7	372	439
	Regenerated cellulosic products (except rayon)	(NA)	606.7	758.0	866.4	866	1,034
	Custom compounded purchased resins	(NA)	523.1	397.2	343.2	278	343
	Consumer and commercial plastics products, n.e.c. and miscellaneous plastics products n.s.k.	(NA)	1,161.9	1,417.5	1,588.2	1,588	1,858

Footnotes:

(1) Figure in line 1 based upon data for resins consumed by SIC 3079 industry in 1967 Source (a) modified to reflect the new classification of this industry. Other figures calculated from this figure using same ratios as for the value of shipments data (see Exhibit XII-3).

(2) Figures for product categories in line 5 determined from value of shipments data using value of shipments per pound of raw material input calculated from data in Source (b). This assumes that the volume of production is reflected in the thermoplastic and thermosetting resins used as raw materials by the SIC 3079 industry and that raw material wastage in production can be neglected.

(3) It has been assumed that the growth in SIC 3079 production volume from 1972 to 1973 is the same as the growth in SIC 2821 sales volume (13.7%). The growth of the various product categories in line 5 are weighted according to their relative growths from 1971 to 1972.

(4) Figures built up from quantities estimated for individual product categories which are estimated to range from a minimum of zero growth to a maximum of a continuation of the historical growth rate from 1971 to 1973.

(5) Figures given in "equivalent" production of SIC 3079 products and for 1971 to 1974 are calculated from figures in line 2 by applying ratio of the total value of SIC 3079 products and services sold by SIC 3079 industry to the value of SIC 3079 products shipped by the industry (see Exhibit XII-3).

(6) Figures for 1971 to 1974 are equal to sum of figures in line 5.

(7) Figures calculated from quantities in line 2 using ratios given in line 4.

(8) Ratios are those which were established for the values of shipments for this industry (see Exhibit XII-3).

Sources:

(a) "Industry Statistics," 1967 Census of Manufacturers, U.S. Department of Commerce, Vol. II, Part 2, Major Groups 25-33, 1971, pp. 30A1-33.

(b) "Shipments of Selected Plastics Products 1972," Current Industrial Reports, U.S. Department of Commerce, Series: MA - 30D (72)-1, November 1973.

EXHIBIT XII-5
FEO: USDC

SIC 3079 - PRODUCTION VOLUME FOR THE THREE MAJOR PLASTIC PROCESSES - 1971 - 1974
(Millions of Pounds)

LINE	ITEM	1971	1972	1973	1974[6] Low	1974[6] High
1.	Thermoplastic resin consumed by SIC 3079 industry[1]	8,059	9,344	10,624	10,624	12,190
2.	Total thermoplastic resin consumed[2]	16,378	20,160	22,926	22,926	26,328
3.	Percent of thermoplastic resin consumed by SIC 3079 industry[3]	49.2	46.3	46.3	46.3	46.3
4.	Percent of thermoplastic resins consumed in the three major processes	80.0	80.0	80.0	80.0	80.0
5.	Thermoplastic resin consumed in the three major plastics processes by SIC 3079 industry[4]	6,447	7,475	8,499	8,499	9,752
	Extrusion[5]	4,513	5,232	5,949	5,949	6,826
	Injection Molding	1,418	1,645	1,870	1,870	2,146
	Blow Molding	516	598	680	680	780
6.	Thermoplastic resin consumed in other processes by SIC 3079 industry	1,612	1,869	2,125	2,125	2,438

Footnotes:

(1) Information based on 1972 figure which was obtained from Source (a), 1972. Figure for 1971 obtained by relating 1972 data to data in Source (b). Figure for 1973 calculated using 13.7% growth in plastics sales in 1973 Source (c).

(2) Figures obtained from Sources (d) and (e).

(3) Estimated based upon data from Source (b).

(4) Figures calculated from quantities given in line 1 using 80 percent factor given in line 3 and relative weightings of volumes of resin processed in the three major processes of 70:22:8 which were estimated from data in Sources (a), (b), (d), and (e).

(5) Includes extrusion coating, extrusion of miscellaneous cross sections, plus Snell estimates for volumes of resin processed into film and sheet based on data from Sources (a), (b), and (c).

(6) Figures for 1974 built up from quantities estimated for individual processes which are estimated to range from a minimum of zero growth to a maximum of a continuation of the historical growth rate from 1971 to 1973.

Sources:

(a) "Miscellaneous Plastic Products, SIC 3079", 1972 Census of Manufactures, U.S. Department of Commerce, Publication MC72(P)-30A-6.

(b) "Shipments of Selected Plastics Products 1972," Current Industrial Reports, U.S. Department of Commerce, Series: MA-30D (72)-1, November 1973.

(c) "We Produced Over 13 Million Tons of Resins in '73," Modern Plastics, Volume 51, No. 1, January 1974, pp. 36-42.

(d) "SPI Flashtics," Society of the Plastics Industry, Volume 3, No. 1, January 1974.

(e) SPI Monthly Statistical Reports and Annual Dollar Sales Surveys.

EXHIBIT XII-6
FEO: USDC
SIC 3079 - ENERGY FACTORS - 1967, 1971, AND 1973
(Per Million Pounds Produced)

Line	Item	Units	Year 1967[1]	1971[1]	1973[2]
1	Production corresponding to the 1967 and 1972 Census Data on Fuels and Energy[1]	Million equivalent pounds	4,690	9,035	(X)
2	BTUs equivalent of fuels	Billion BTUs	5.54	4.24	3.8
3	Coal	1,000 short tons	0.020	0.0085	0.003
4	Distillates	1,000 barrels	0.112	0.097	0.09
5	Residual	1,000 barrels	0.172	0.056	0.002
6	Natural gas	Billion cu. ft.	0.00315	0.0030	0.003
7	Other fuels				
8	Fuels nsk.				
9	Electricity purchased	Million KWH	1.58	1.02	0.74
10	BTUs equivalent of purchased electricity	Billion BTUs	16.75	10.81	7.84
11	Electricity generated	Million KWH	(Z)	(Z)	(Z)
12	BTUs equivalent of fuels and purchased electricity	Billion BTUs	22.29	15.05	11.6

(1) Census data from "Fuels and Electric Energy Consumed," MC67(S)-4 and MC72(SR)-6 divided by Line 1, derived from data in Exhibit XII-4.
(2) Straight line extrapolation of 1967 to 1973 trends.

EXHIBIT XII-7
FEO: USDC
RESPONSES TO SPI[1] SURVEY OF
MEMBER COMPANIES REGARDING THE
"ENERGY/RESIN EMERGENCY" -
NOT AUDITED BY SNELL

BASIS: Responses from 228 processors, out of about 900 with 146 employees and $4.6 million sales as the median size. Not all respondents answered each inquiry item.

Item	Extent of Impact
. Companies that have cut back operations	. 52% of respondents to the item have cut back . The average cutback for all respondents to item was 12% with a range of 0 to 75%
. Companies that have laid off employees	. 41% of respondents to the item have laid off employees . The average layoffs for all respondents was 10 employees with a range of 0-228
. Average operating level in January 1974 compared with first half of 1973	. 82% average operating level was projected for all respondents to the item . The anticipated average number of employees to be laid off by respondents to the item by January 1974 was 16 with a range of 0-240 . Of the respondents to the item, 36% expected an operating level of 100% or better
. Companies that have participated in a "save energy" program	. 96% of respondents to the item participated

(1) Compilation of responses through the end of January 1974 from a December 1973 survey by the Society of Plastics Industry (SPI)

EXHIBIT XII-8
FEO: USDC
RESPONSES TO A "PLASTICS WORLD" SURVEY (1)
OF A RANDOM SAMPLE OF THE COMPANIES ON
THEIR SUBSCRIPTION LISTS - NOT AUDITED
BY SNELL

BASIS: About 220 respondents from 1,000 questionnaires sent to firms having over $1.5 million sales.

Item	Extent of Reported Impact
. Companies that have cut back their production schedules	. 56% of respondents to the item have cut back
	. The gross average cutback for all respondents to the item was 14.5%
. Companies that have laid off or temporarily furloughed employees	. 51% of respondents to the item have laid off employees
	. The gross average cutback of labor force for all respondents to this item is 11% of the labor force
. Companies that report present shortage of supplies	. 46% of respondents to the item report present shortage
	. Gross average present shortfall for all respondents to the item is 19% of requirements
. Outlook for further employee layoffs	. likely - 25% . possible - 59% . unlikely - 14%
. Problems with suppliers	. 15% have been totally shut off
	. 65% are on a reduced allocation (70-75% of last year's purchases)

(1) Plastics World, March 18, 1974

EXHIBIT XII-9 [1]
FEO: USDC
RESPONSES TO A MEMBERSHIP SURVEY CONDUCTED BY THE ORGANIZATION OF PLASTICS PROCESSORS (TOPP)-NOT AUDITED BY SNELL

BASIS: About 250 respondents from December 1973 through mid-February 1974, to a questionnaire included in the membership applications to TOPP. The average size of the respondents was roughly estimated to be about 55 employees

Item	Extent of Reported Impact (Preliminary Analysis)
. Companies that have cut back their production schedule	. 70 ± 2% of respondents cut back . the gross average cutback for all respondents stands at about 25 to 30%, and the cutback actually reported by those cutting back was 35 to 40%
. Companies that laid off employees (including temporary or permanent shut downs).	. 70 ± 2% of respondents cutback . the average layoff is 18 employees for all respondents to the questionnaire . total layoffs for the respondents are 4,000 to 4,500 employees . this represents about 25 to 30% of the total labor force
. Companies that report shortage of supplies	. 70 ± 2% of respondents report shortages . 30% of the companies experience: - a reduction of 35 to 40% of historic supplies - a reduction of 30% of procurements . 10% receive 20% of their historic supplies . 30% receive 100% of their historic supplies
. Outlook for future layoffs	. 90% of respondents feel this is likely
. Problem with suppliers	. 30 ± 2% are cut off from their supplies
. Outlook for supplies	. Most companies report that suppliers commitments do not extend beyond April 1, 1974.

(1) Private communication to Snell by Mr. John English, Executive Director, TOPP, February 27, 1973.

EXHIBIT XII-10
FEO: USDC
LIMITED SURVEY BY SNELL OF PLASTICS PROCESSORS REGARDING THE EMPLOYMENT IMPACTS OF THE SHORTAGES - SIC 3079

- During the week of February 25, 1973, Snell conducted a limited telephone survey of the chief executive officers of 11 processors in the one to four million dollar sales range (about one hundred employees).
  - five respondents reduced their work force, on the average, by 25%
  - four will maintain their work force at 1973 levels
  - one will increase the number of people in their employ
- Besides the decrease in the number of people employed, overtime has been eliminated and a reduction in the work week from five to three days has been instituted by some respondents.
- According to most respondents the January 31 action of the Cost of Living Council to decontrol petrochemicals and resins is expected to result in an 18 to 25% increase in the cost of products in the form of pass thoughs.
  - raw material shortages are, however, expected to persist
  - the pattern of declines in employment is not expected to improve appreciably in the near-term due to lack of raw materials.

EXHIBIT XII-11
FEO: USDC
DISTRIBUTION OF EMPLOYMENT
SIC 3079 - BY SIZE OF ESTABLISHMENT
1971 AND 1972

Employment Size Class	Number of Establishments 1971	1972
1-3	961	940
4-7	757	831
8-19	1,238	1,233
20-49	1,228	1,306
50-99	634	716
100-249	492	551
250-499	131	156
Over 500	45	47
	Total Number of Employees	
All Sizes	261,000	288,000

(1) Source: County Business Patterns, 1971 and 1972

APPENDICES

APPENDIX A

CONVERSION TABLE AND REQUIRED SYMBOLS

Type of Material or Energy	Unit of Measure	Equivalent To Thousand BTUs	Equivalent To Kilowatt-hours
Propane, butane & mixtures	Barrel	4,011	1,175
Middle distillates	Barrel	5,825	1,707
Residual fuel oil	Barrel	6,287	1,842
Chemical feedstocks	Barrel	4,011	1,175
Other Petroleum Products			
Gasoline	Barrel	5,253	1,539
Kerosine	Barrel	5,670	1,661
Lubricants	Barrel	6,065	1,777
Wax	Barrel	5,537	1,622
Asphalt	Barrel	6,636	1,944
Residual fuels, pet., coke, acid sludge	Barrel	6,006	1,760
Miscellaneous	Barrel	5,796	1,698
Coal	Short Ton	26,201	7,677
Anthracite	Short Ton	25,400	7,442
Bituminous	Short Ton	28,900	8,468
Lignite	Short Ton	14,770	4,328
Natural Gas	Thous. cu. ft.	1,032	303.3
Fuels, n.e.c.	Thous. cu. ft.	550	161.2
Coke oven gas	Thous. cu. ft.	550	161.2
Blast furnace gas	Thous. cu. ft.	92	27.0
Still gas	Thous. cu. ft.	1,501	439.8
Coke	Short Ton	26,000	7,618
Coke screening and breeze	Short Ton	20,488	6,003
Electrical Energy (1)	Kilowatt-hour	10.6	3.1

* * * * *

Required Symbols

(NA) = not available   (X) = not applicable   (Z) - negligible

(1) To replace fossil fuel as input to electricity generation

Source: U. S. Department of Commerce

APPENDIX B

RELIABILITY RATINGS

The detailed methodology used and the factors affecting data reliability are presented as concise footnotes with each Required Table or other exhibit in each industry study.

The same reliability rating applies to large blocks of data in many of the Required Tables, because the source of individual data points as well as the estimation procedure is identical. For the sake of conciseness of presentation and report volume, possible error ratings are summarized in a single exhibit, following. The table below provides the key to ratings.

Rating	Possible Percentage Error
1	± 5
2	± 5-10
3	± 10-20
4	± 20 or more

EXHIBIT B-1
FEO: USDC
DATA RELIABILITY RATINGS

SIC	Industry	RT 1(1)		RT 2,3,4		RT 5			RT 6		RT 7		RT 8						RT 9	RT 10	RT 11	RT 12
		Shipments	Production	1971	1973	1971	1973	1974	Grand Total	Other Columns	Grand Total	Other Columns	1971 Shipments	1973 Shipments	1971 Employment	1973 Employment	1971 Fuels and Energy	1973 Fuels and Energy				
2821	Plastics Materials	2	2	3	3	3	3	4	4	4	4	4	2	3	3	3	3	3	4	(X)	(X)	3
2822	Synthetic Rubber	1	1	2	2	2	2	3	3	3	3	3	1	2	2	2	3	3	4	4	4	4
2823	Cellulosic Man-Made Fibers	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	(X)	(X)	(X)
2824	Organic Fibers	1	1	3	3	3	3	4	4	4	4	4	1	2	2	3	3	3	3	(X)	(X)	(X)
3011	Tires	1	1	(X)	(X)	2	2	3	3	3	3	3	1	2	2	3	3	3	4	(X)	(X)	3
3021	Rubber Footwear	1	2	(X)	(X)	2	2	3	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	4	(X)	(X)	3
3031	Reclaimed Rubber	1	1	3	3	2	2	3	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	4	(X)	(X)	4
3069	Rubber Products	2	(X)	(X)	(X)	3	3	4	4	4	4	4	2	3	3	3	3	3	(X)	(X)	(X)	(X)
3079	Plastics Products	2	2	(X)	(X)	3	4	4	4	4	4	4	2	3	3	3	3	4	(X)	(X)	(X)	(X)

(1) "RT" means required table.
(2) Reason for these ratings are apparent in the methodology presented as footnotes for each table and discussion in the text.